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Springfield, VA

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ABSTRACT

This report presents the results and conclusions of a Source Test and Evaluation Program conducted at a coal preparation facility. The preparation plant is classified in Site Category 1 which has a low soil neutralization potential, low pyritic sulfur content coal, high area rainfall and a high technology level of cleaning. The major objective of the test program was to perform an environmental assessment on the facility's waste streams and fugitive emissions.

Results from the chemical analyses indicated that all streams, except for fugitive particulates, contained constituents which may have a potentially harmful health and/or ecological effect. For streams which showed potential for ecological effects, manganese was found to be of concern; for streams which showed a potentially harmful health effect, the heavy metals manganese and chromium were of prime concern. Contrary to previous studies, high ammonia concentrations were also observed. Further investigation of the ammonia source is warranted.

The bioassay test results for all fugitive particulates were negative. The sedimentation pond waters, the coarse refuse, and fine refuse slurry solid samples indicated moderate biological effects. For leachate, all health-related bioassay tests showed a low or nondetectable effect; however, the coal and coarse refuse leachate composite and the pond sediment composite produced a moderate effect on the ecological-related algae test.

The results of this environmental assessment identified tailing ponds and associated sediments as the sources of greatest potential hazard due to high heavy metal concentrations.

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GLOSSARY

Ames Assay: The Salmonella/Microsome Mutagenesis Assay. This test is used as a primary screen to determine the mutagenic potential of complex mixtures.

CHO Assay: Chinese Hamster Ovary Clonal Assay. This test quantitatively measures the cellular metabolic impairment and death resulting from in vitro exposure to soluble and particulate toxicants.

Discharge Severity (DS): An index of the potential hazard of a single substance in a discharge.

EC_{50}: Median effective concentration. The calculated dose of a chemical substance which is expected to affect 50 percent of an entire population of an experimental animal species as determined from exposure to the substance by any route other than inhalation.

Grav: Gravimetric organics analysis.

ICP-OES: Inductively Coupled Argon Plasma Optical Emission Spectroscopy. An analytical method used primarily to measure the concentration of metals in liquids and solids.

IERL-RTP: Industrial Environmental Research Laboratory at Research Triangle Park, N.C.

Level 1: The screening phase in the tiered chemical/biological analysis approach.

Level 2: The confirmation phase in the tiered chemical/biological analysis approach.

Level 3: The risk assessment phase in the tiered chemical/biological analysis approach.

GLOSSARY (Continued)

Multimedia Environmental Goals (MEG): Estimated levels of contaminants or degradants in ambient air, water, or land (referred to as AMEG) or in emissions or effluents (referred to as DMEG) conveyed to the ambient media that (1) will not produce negative effects in the surrounding populations or ecosystems, or (2) represent control limits achievable through technology.

RAM Assay: Rabbit Alveolar Macrophage Assay. A bioassay test measuring cytotoxicity using primary cultures of rabbit alveolar (lung) cells. This test defines the cellular toxicity of airborne particulates and associated chemicals.

Rodent Acute In-Vivo Test: A bioassay test measuring whole animal toxicity using rats. Toxicological effects are noted over the following 14-day period.

ROM: Run-of-Mine.

SAM: Source Analysis Model.

SAM/1A: The simplest member of the Source Analysis Models. SAM/1A estimates a Discharge Severity Value equal to the ratio of a specific pollutant concentration in an effluent stream to its corresponding health or ecological based mate value.

SSMS: Spark Source Mass Spectrophotometry.

STER: Source Test and Evaluation Report.

TCO: Total Chromatographable Organics.

Total Discharge Severity (TDS): An index of the potential hazard of all substances in a single discharge. Equal to the summation of the individual Discharge Severity Values in a given emission stream.

SECTION 1.0

EXECUTIVE SUMMARY

1.1 INTRODUCTION

Versar Inc., of Springfield, Virginia, under contract to the Environmental Protection Agency - Industrial Environmental Research Laboratory (EPA-IERL) is performing a comprehensive environmental assessment of coal preparation technologies. A significant part of this assessment involves Source Test and Evaluation (STE) programs at operating coal cleaning facilities. The primary objectives of each STE program are to gather sufficient data to characterize multimedia emissions from the source, to assess that data on a health and ecological basis, and to evaluate the effectiveness of pollution control systems.

1.2 PROGRAM SUMMARY

One of the processes of particular interest to EPA's energy-related technology assessment programs is coal cleaning, primarily because of its potential role in the control of sulfur dioxide emissions from industrial, commercial, and utility boilers. For several years, EPA has supported test work to investigate the usefulness of coal cleaning as a means of minimizing the pollution associated with utilization of coal.

The purpose of the coal cleaning portions of EPA's assessment program is to establish a strong base of engineering, ecological, pollution control, and cost data that can be used to determine which coal cleaning processes are most acceptable from the environmental, technological, and economic viewpoints. The data will also be used for pollution control trade-off studies comparing the various individual and combination techniques, such as coal cleaning combined with stack gas scrubbing, to reduce the pollution potential of coal-fired power plants. In addition, the data will be used to identify the areas where development of pollution control equipment is needed.

To characterize the overall control of emissions from coal use, it is necessary to assess the pollution potential of coal cleaning processes and allied operations. One phase of Versar's program for assessing coal cleaning processes involves a field sampling and analysis task designed to identify the combinations of coal cleaning processes and environmental conditions that most effectively reduce the total impact of coal use on the environment. The field testing program is being planned at selected coal cleaning facilities throughout the United States. The objective is to characterize effluent streams from a variety of such facilities and from their associated coal transportation, storage, and refuse disposal areas. Sampling points will be located upstream and downstream of pollution control equipment and of points of application of waste treatment techniques. This sampling scheme will determine the effectiveness of these pieces of equipment or techniques in reducing the potential pollution loading on the environment. Pollutant emissions of interest include leachate and runoff from coal storage and refuse disposal piles; leachate from slurry holding and disposal pond sediments; and fugitive particulates and vapors from coal handling and storage piles, refuse piles, and plant operations. Thermal dryer gases and particulates will be sampled at selected plants where the clean coal is dried. These field data will be obtained by conducting environmental source assessments of process and effluent streams using the sampling and analysis approach developed by EPA-IERL/RTP.

The field testing program is intended to determine the physical, chemical, and toxicological characteristics of effluent streams sampled at their respective sources, rather than to assess the environmental quality in the general vicinity of the cleaning plant. Therefore, results of the present testing program cannot be used to evaluate cause/effect relationships between effluent streams and ecological effects observed in the field.

1.3 ENVIRONMENTAL ASSESSMENT TASK

1.3.1 Plant Selection

To select coal cleaning plants throughout the U.S. for the field testing program, a site selection scheme was devised which assists in the selection of plants in ten site categories. The site categories are based on four variables considered to be of prime importance in determining the pollution potential of any given coal cleaning plant:

- Acid neutralization potential of the soil in the plant area.
- Pyritic sulfur content of the raw coal.
- Average annual precipitation.
- The relative sophistication of coal cleaning technology.

Although there are 16 possible combinations of these four variables, currently operating coal cleaning plants comprise only ten of the possible combinations.

In the site-selection procedure, several constraints were imposed to assure that the requirements of the overall environmental assessment program would be satisfied and that the program would be cost effective. These constraints resulted, in part, from a decision to select plants which represented extremes (high and low) in values of the variables to be tested (for example, pyritic sulfur levels, environmental settings, and various kinds of coal cleaning and pollution control technologies employed) rather than average or typical conditions. By examining the extremes in the variables, it was felt that it would be possible to investigate the contribution of each individual variable in affecting the total environmental burden imposed by cleaning.

1.3.2 Description of Coal Preparation Plant No. 1

The coal cleaning plant chosen for this first assessment is located in western Kentucky and cleans Kentucky No. 9 and No. 11 coals. Throughout this report, the facility will be called coal preparation plant No. 1. This facility represents the group of cleaning plants that process run-of-mine (ROM) coal with low pyritic sulfur (≤ 2 percent pyritic sulfur) content, use high technology coal cleaning processes, operate in an environment with high rainfall (≥ 60 cm/yr), and have a low soil neutralization potential (pH <6.0). The clean coal from this plant is sent directly to a large steam electric power plant. During the sampling period both Kentucky seam coals were cleaned.

A block diagram of the coal preparation plant highlighting major waste streams is given in Figure 1-1. The diagram shows that the stored ROM coal is initially sent to a raw coal screen. The overflow from the raw coal screen is treated in a Baum jig, which produces two product streams, a coarse and a middling fraction, and a refuse stream. The product streams are dewatered and sent to the clean coal pile.

The underflow from the raw coal stream and dewatering circuit are combined to process fine coal. The fine coal stream is cleaned in a bank of hydrocyclones. Recovery is accomplished by centrifugation of the fine coal slurry after collection and initial thickening by classifying cyclones.

1.3.3 Test Program Description

Samples of 25 process and waste streams were obtained to meet the objectives of this STE program. Because slurry streams were split into their respective solid and liquid states, and solids (non-fugitive) were treated for leachability, a total of 31 samples were analyzed to characterize the facility's raw materials, waste streams, and product.

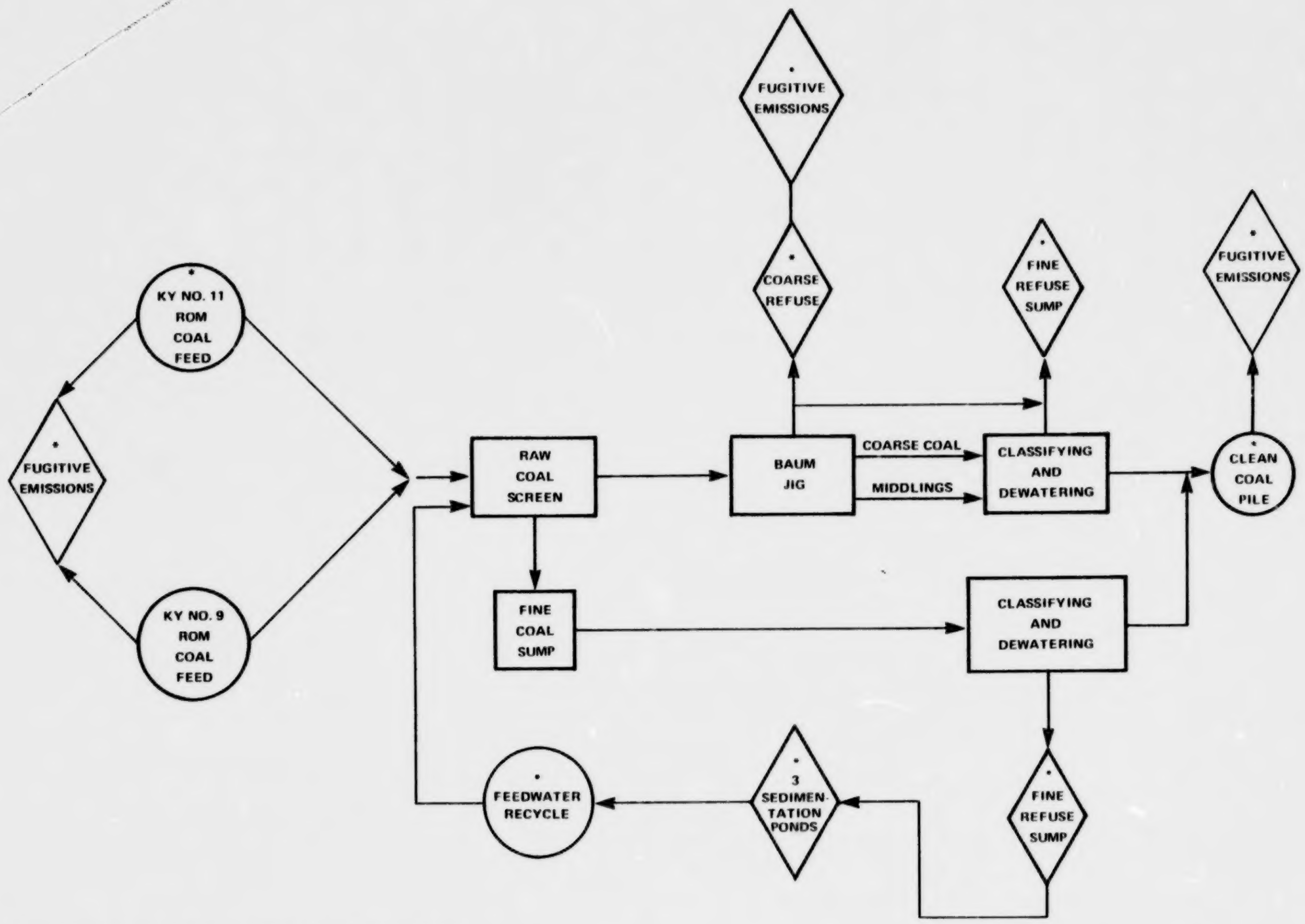
The sampled waste streams from the coal preparation facility included the following:

- Fugitive particulates and gases (non-point source) from coal and coarse refuse storage areas.
- Fine refuse slurry sedimentation ponds.
- Runoff from coal and coarse refuse storage areas.
- Coarse refuse.
- Fine refuse slurry.

These streams were selected based on their potential for pollution and accessibility.

General analyses were performed on most streams, including:

- Chemical analysis by spark source/mass spectroscopy for inorganic element determination (all streams).
- Chemical analysis by inductively coupled argon plasma for certain inorganic elements (liquid streams only).


* KY NO. 11 ROM COAL FEED
KY NO. 9 ROM COAL FEED
* FUGITIVE EMISSIONS
RAW COAL SCREEN
FINE COAL SUMP
BAUM JIG
* COARSE REFUSE
* FUGITIVE EMISSIONS
COARSE COAL
MIDDLINGS
CLASSIFYING AND DEWATERING
* FINE REFUSE SUMP
* CLEAN COAL PILE
* FUGITIVE EMISSIONS
CLASSIFYING AND DEWATERING
* FINE REFUSE SUMP
* 3 SEDIMENTATION PONDS
* FEEDWATER RECYCLE

*STREAMS SAMPLED FOR SOURCE TEST AND EVALUATION TASK

FIGURE 1-1 SCHEMATIC FLOW DIAGRAM OF COAL PREPARATION PLANT NO. 1

- Chemical analysis for total chromatographable organics and gravimetric analysis for assessing total organic content (all gaseous, liquid, and sediment streams).
- Mercury analysis by atomic absorption spectroscopy (all streams).
- Chemical analysis for general water quality parameters for each liquid stream.
- AMES tests for mutagenesis (all streams).
- A second, suitable biological assessment test (all non-gaseous streams).

1.4 SOURCE TEST ENVIRONMENTAL ASSESSMENT SUMMARY

Preparation plant No. 1 is a 450 kkg/h (500 tph) coal washing plant. Its yield is about 249-272 metric tph of clean coal (i.e., 55-60 percent yield). The plant cleans Kentucky No. 9 and No. 11 coal to yield a product which has an average yearly total sulfur content of 2.9 percent (as-received) and an energy content of about 26,000 kJ/kg (11,000 Btu/lb).

1.4.1 Sample Stream Characterization

To provide a rapid screening technique for evaluating the pollution potential of the waste streams, the simplest member of the Source Analysis Models (SAM/1A) was used.

There are several assumptions implicit in the use of the SAM/1A evaluation technique. The major assumptions include:

- The MEGs methodology does not consider synergisms or antagonisms with regard to health or ecology. Severity is considered as simply additive.
- Persistence in the environment with regard to bioaccumulation or degradation is not specifically considered in the current MEGs.
- The level of confidence to be associated with MEGs values derived from the models is not known.
- Extrapolation of acute toxicity data for animals (i.e., LD_{50}) to no effects levels in man entails many assumptions which are not properly validated.

SAM/1A estimates a "discharge severity" which is the ratio of a specific pollutant concentration in an effluent stream to its corresponding health or ecological based DMEG value (Discharge Multimedia Environmental Goals). For example, the estimated concentration of aluminum in the fine waste slurry filtrate sample was analyzed to be 190 μg/ℓ. The health-based DMEG value for aluminum in a liquid discharge is 8.0×10^4. To calculate the discharge severity (DS) value for aluminum, 190 μg/ℓ is divided by the DMEG value, 8.0×10^4 and the discharge severity is 2.4×10^{-3} or 2.4E-3. The Total Discharge Severity (TDS) can be calculated by summing the individual discharge severity values.

DMEGs are values that, when used with source analysis models, allow quantification of interactions between a source and its environment. It should be emphasized that DMEGs are not to be treated as regulations. They are designed for use in ranking chemicals on the basis of predicted environmental acceptability.

Except for fugitive particulates samples, all streams were found to contain some constituents in potentially harmful concentrations. Table 1-1 gives an overview of the test results for all waste streams. An "X" was placed in the first two columns if a waste stream contained one or more chemical constituents with a significant discharge severity (i.e., DS >1). The last two columns of the table summarize the significant biological results (i.e., moderate results for a health-or ecological-related bioassay). Because there were four possible health bioassays and three possible ecological bioassays, the table indicates the number of tests showing moderate effects out of the number of tests performed. Clearly, the pond water, fine waste slurry, sediments and sediment leachate samples show the greatest potential for health and ecological effects.

The TDS value is an indication of the potential for harmful effects for an entire waste stream. TDS values for several streams may be compared to indicate the streams that are likely to become the initial candidates for further characterization (Level 2 environmental assessment) or treatment. Figure 1-2 depicts the TDS values for all waste streams as a summary of the SAM/1A evaluation. The TDS values for all waste

TABLE 1-1. OVERVIEW OF TEST RESULTS INDICATING POTENTIAL FOR HEALTH AND ECOLOGICAL EFFECTS

Waste Stream	Individual Constituent(s) Showing Discharge Severity Value Greater Than One		Number of Biological Tests Showing Moderate Effects	
	Health	Ecological	Health	Ecological
Particulates				
Clean Coal Fugitive Particulates				NC
Coarse Refuse Fugitive Particulates				NC
ROM Coal Fugitive Particulates				NC
Upwind Fugitive Particulates				NC
Downwind Fugitive Particulates				NC
Vapors				
Clean Coal Vapors	X			NC
Coarse Refuse Vapors	X			NC
ROM Storage Pile Vapors	X			NC
Upwind Vapors	X			NC
Downwind Vapors	X	X		NC
Water				
Feedwater		X		NC
Pond Water #1		X	1 of 2	1 of 3
Pond Water #2		X	1 of 2	1 of 3
Pond Water #3		X	1 of 2	1 of 3
Runoff				
ROM Storage Pile Runcff		X		NC
Clean Coal Storage Pile Runoff	X	X		NC
Coarse Refuse Pile Runoff	X	X		NC
Solids and Leachates				
Unfiltered Fine Waste Slurry	NC	NC		2 of 3
Fine Waste Slurry Filtrate	X	X	NC	NC
Fine Waste Slurry Filtered Solids	X	X		NC
Coarse Refuse	X	X	1 of 2	NC
Coarse Refuse Leachate		X		1 of 3
ROM Coal	NC	NC		NC
ROM Coal Leachate		X		1 of 3
Clean Coal	NC	NC		NC
Clean Coal Leachate	X	X		1 of 3
Pond #1 Sediment	X	X		NC
Pond #1 Sediment Leachate	X	X		1 of 3
Pond #2 Sediment	X	X		NC
Pond #2 Sediment Leachate	X	X		1 of 3
Pond #3 Sediment	X	X		NC
Pond #3 Sediment Leachate	X	X		1 of 3

NC = Not Conducted

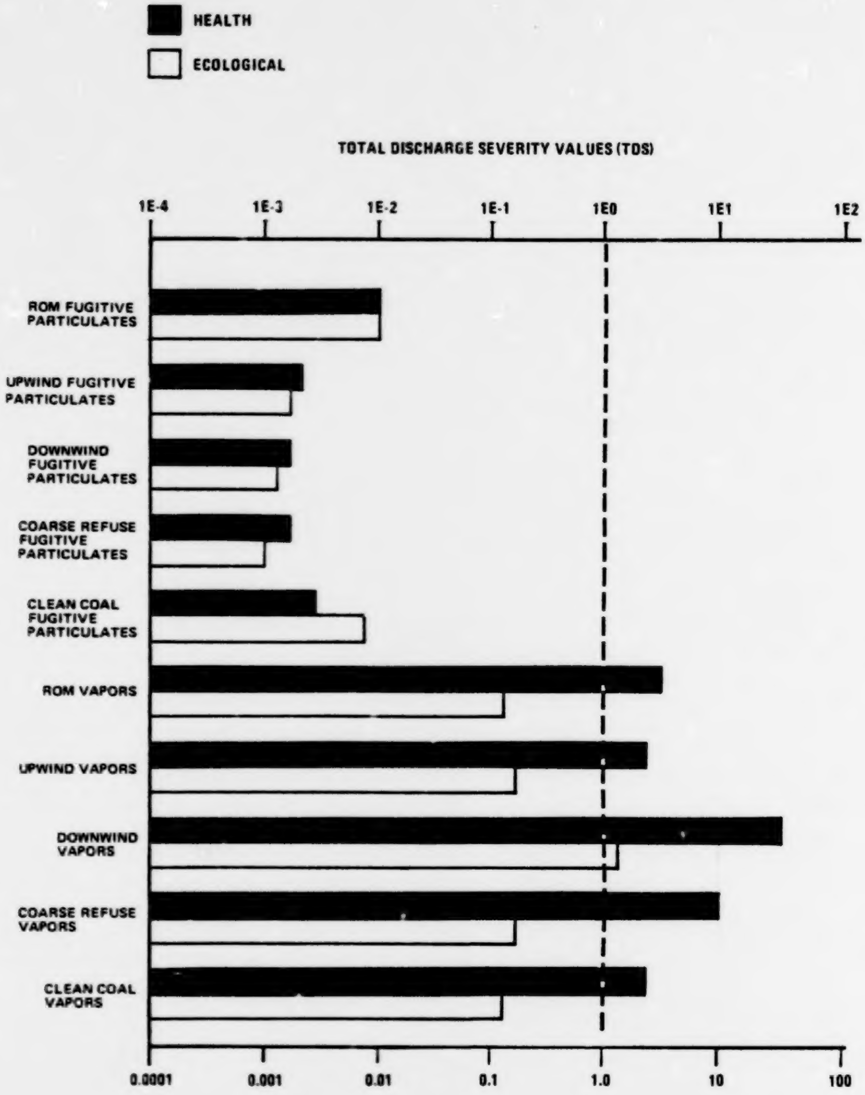


FIGURE 1-2 TOTAL DISCHARGE SEVERITY VALUES FOR ALL SAMPLE WASTE STREAMS FOR COAL PREPARATION PLANT NO. 1

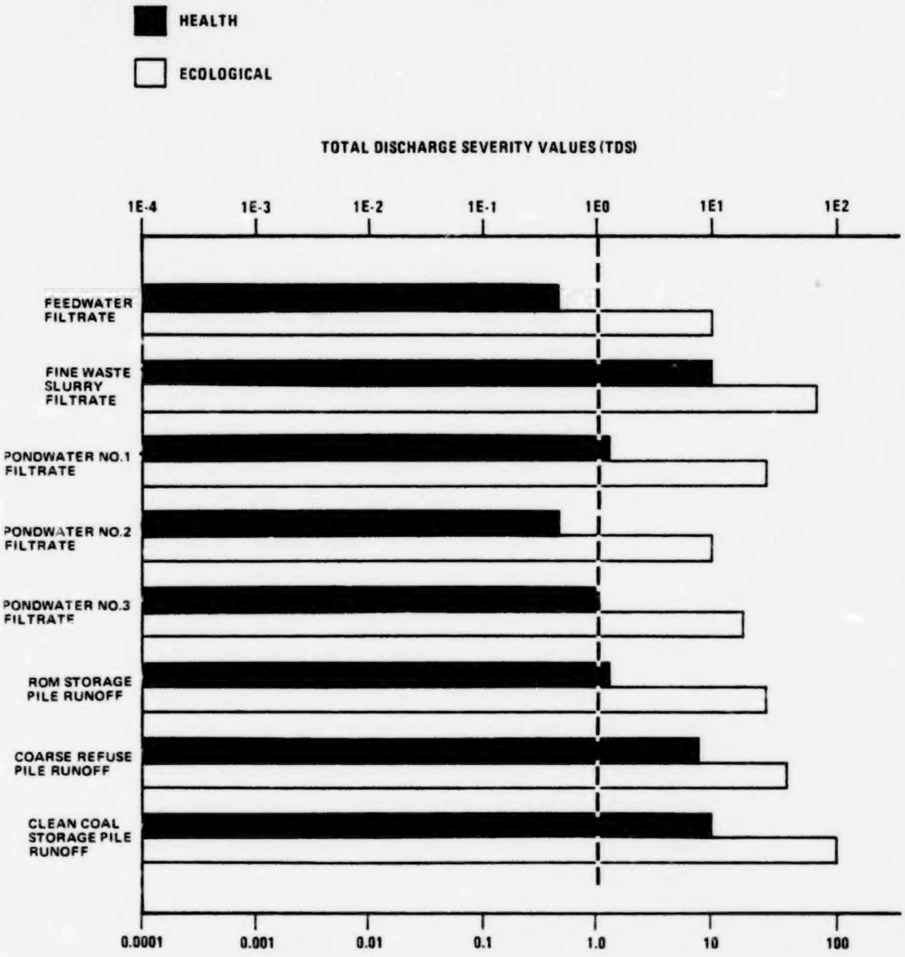


FIGURE 1-2 TOTAL DISCHARGE SEVERITY VALUES FOR ALL SAMPLE WASTE STREAMS FOR COAL PREPARATION PLANT NO. 1 (CONTINUED)

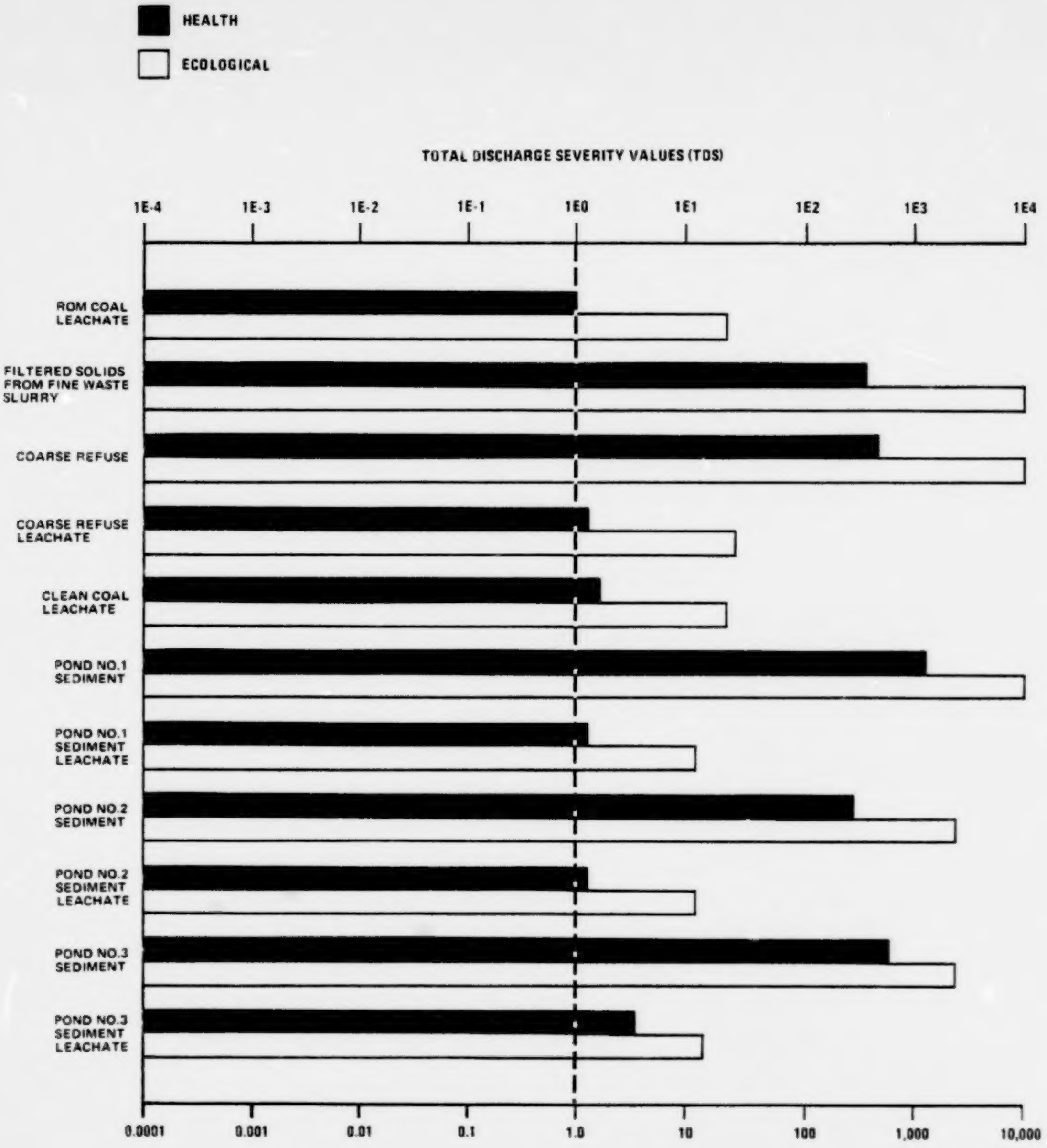


FIGURE 1-2 TOTAL DISCHARGE SEVERITY VALUES FOR ALL SAMPLE WASTE STREAMS FOR COAL PREPARATION PLANT NO. 1 (CONTINUED)

streams ranged from .005 to 10,000 with the majority of the streams having a TDS value of less than 100. The discharge severity is an index of the potential hazard of a single substance in a discharge. For most streams with an ecological-related TDS greater than 100, the major contributors were ammonia, phosphorus, and manganese; for high health-related TDS values, the major contributors were manganese and chromium.

A detailed summary of the biological assay tests results is shown in Figure 1-3. Thirty samples were evaluated by the Ames Assay and were found to be nonmutagenic (low or nondetectable effects). Eight sample were evaluated by the RAM assay and all were found to produce low or nondetectable effects with the exception of coarse refuse, which produced a moderate effect. Eleven samples were evaluated by the CHO Clonal Assay and all were found to be nontoxic with the exception of unfiltered pond water from ponds #1, 2, and 3, which produced a moderate effect. A sample of unfiltered fine refuse was evaluated by the Rodent Acute In-Vivo Test and shown to be nontoxic. Four samples were evaluated by aquatic bioassays with fish and invertebrates; all were found to be nontoxic with the exception of unfiltered fine refuse, which had a moderate effect on the invertebrate. The same four samples were evaluated by aquatic bioassays with an alga and were found to have moderate effects.

A summary of the multimedia chemical and biological stream characteristics and control strategy recommendations is provided in Table 1-2.

1.4.2 Fugitive Particulates and Vapors

Fugitive particulates and vapors were sampled downwind of coal handling and storage piles, refuse piles, and upwind and downwind of plant operations. The fugitive samples had relatively high total suspended particulate (TSP) and total organic concentrations and low TDS values. The TSP and hydrocarbon values were highest around the coal piles, probably because of continuous coal handling operations and diesel truck activities. To determine the contribution of the plant to ambient air concentrations, upwind values were subtracted from downwind concentrations. The resulting downwind contribution was 175 $\mu g/m^3$ for total suspended particulates (compared to the 24-hour primary and secondary ambient air quality

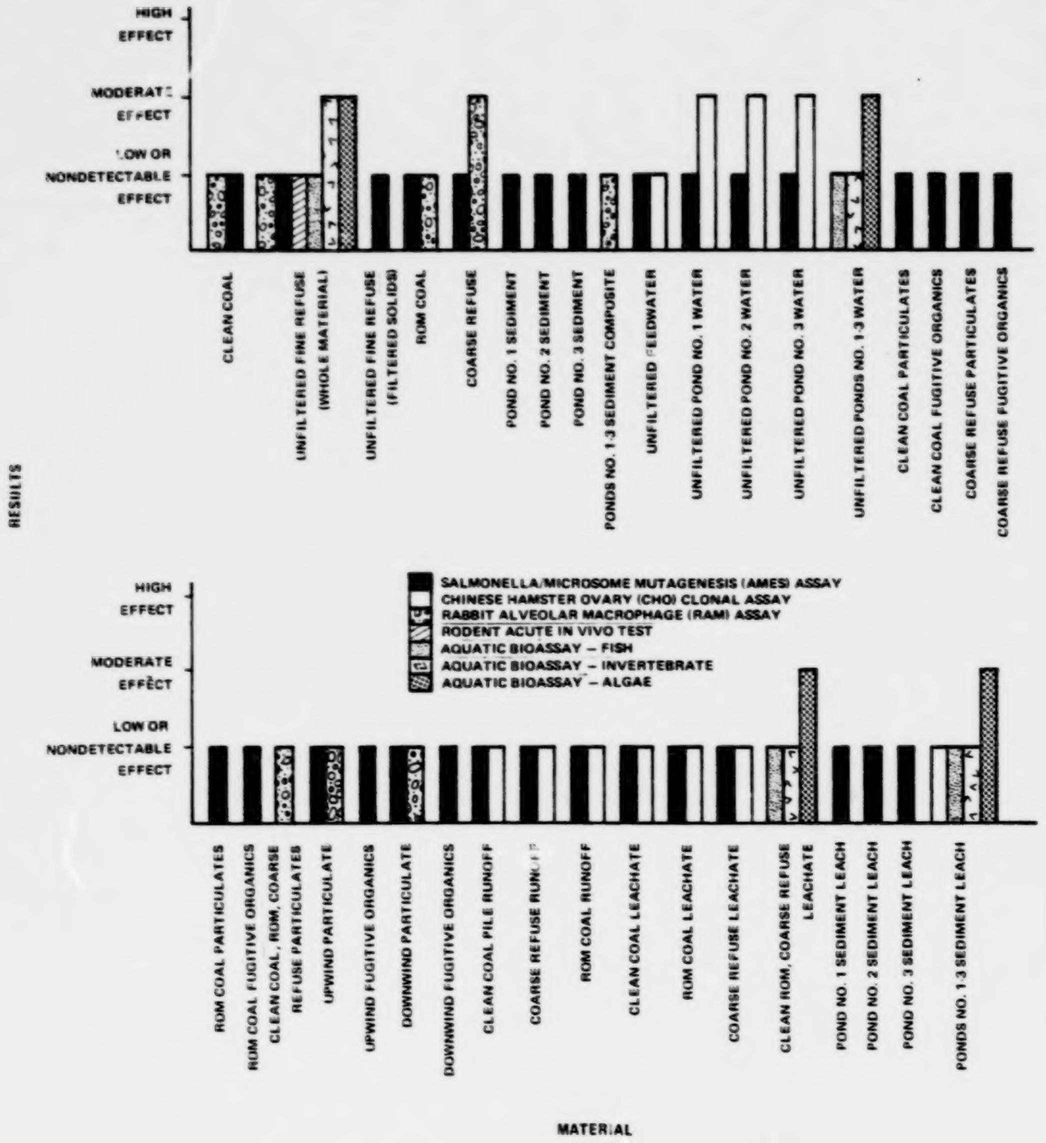


FIGURE 1-3 RESULTS OF HEALTH AND ECOLOGICAL EFFECTS TESTS FOR MATERIALS ASSOCIATED WITH COAL PREPARATION PLANT NO. 1

TABLE 1-2. SUMMARY OF ENVIRONMENTAL RESULTS

Waste Stream	Total Discharge Severity		Major Contributors (Discharge Severity >10)		Biological Results		Conclusions	Recommendations
	Health	Ecological	Health	Ecological	Health	Ecological		
Clean Coal Fugitive Particulates	5E-3	9E-3	-	-	L.N.	N.C.	● Low potential for hazard according to TDS values and bioassay test results. ● High downwind TSP values for particulates. ● Particulate morphology shows mostly dust, not coal, in downwind samples.	● Improve dust control/ suppression techniques.
Coarse Refuse Fugitive Particulates	3E-3	1E-3	-	-	L.N.	N.C.		
ROM Fugitive Particulates	1E-2	1E-2	-	-	L.N.	N.C.		
Upwind Fugitive Particulates	4E-3	3E-3	-	-	L.N.	N.C.		
Downwind Fugitive Particulates	3E-3	2E-3	-	-	L.N.	N.C.		
Clean Coal Storage Pile Vapors	3E0	2E-1	-	-	L.N.	N.C.	● Low potential for hazard according to TDS values and bioassay test results.	
Coarse Refuse Pile Vapors	1E1	3E-1	-	-	L.N.	N.C.		
ROM Storage Pile Vapors	4E0	2E-1	-	-	L.N.	N.C.		
Upwind Vapors	3E0	3E-1	-	-	L.N.	N.C.		
Downwind Vapors	6E1	2E0	Cr	-	L.N.	N.C.		

TABLE 1-2 SUMMARY OF ENVIRONMENTAL RESULTS (continued)

Waste Stream	Total Discharge Severity		Major Contributors (Discharge Severity 10)		Biological Results		Conclusions	Recommendations
	Health	Eco-logical	Health	Eco-logical	Health	Eco-logical		
Fine Waste Slurry * Filtrate	1E1	7E1	NH_3-N	NH_3-N	N.C.	N.C.	• Potentially hazardous according to SAM/1A evaluation.	• Should not discharge directly to offsite surface waters; should be treated onsite.
Feedwater Filtrate *	7E-1	1E1	-	-	L.N.	N.C.	• Low potential for hazard according to TDS values and bioassay test results.	
Pond Water No. 1 * Filtrate	2E0	3E1	-	NH_3-N	M	M	• Potentially hazardous for ecological-based SAM/1A evaluation. • Complied with most stringent state effluent regulations for states in Eastern, Midwest and Northern Appalachian coal regions.	• Further characterization during Level 2 environmental assessment phase to determine origin of ammonia.
Pond Water No. 2 * Filtrate	7E-1	1E1	-	-	M	M		
Pond Water No. 3 * Filtrate	1E0	2E1	-	-	M	M		
ROM Storage Pile Runoff	2E0	3E1	-	NH_3-N	L.N.	N.C.	• Low potential hazard for health-based criteria. • Potentially hazardous for ecological-based criteria. • Water quality results in compliance with most stringent state effluent regulations.	• Collect runoff and treat for control of manganese. • Further characterization during Level 2 environmental assessment phase to determine origin of ammonia.
Clean Coal Storage Pile Runoff	1E1	1E2	-	Mn,Ni,NH_3-N	L.N.	N.C.		
Coarse Refuse Pile Runoff	9E0	4E1	-	Mn	L.N.	N.C.		

TABLE 1-2. SUMMARY OF ENVIRONMENTAL RESULTS (Continued)

Waste Stream	Total Discharge Severity		Major Contributors (Discharge Severity >10)		Biological Results		Conclusions	Recommendations
	Health	Ecological	Health	Ecological	Health	Ecological		
Filtered Solids from Fine Waste Slurry	6E2	1E4	Cr,Mn,Ba, Be,Cd,Li, P,Se,V	P,Cd	M	M	• Potentially hazardous according to SAM/1A evaluation.	• Retain material onsite via sedimentation or filtration.
Coarse Refuse	7E2	1E4	Cr,Mn,As, Ba,Be,Pb, Li,P,Se,V	P,Ni	M	N.C.	• Potentially hazardous according to SAM/1A evaluation. • Does not exceed RCRA EP Toxicity Concentrations.	• Further characterization during Level 2 environmental assessment phase to determine origin of ammonia.
Coarse Refuse Leachate	2E0	4E1	-	NH_3-N	L.N.	M		
ROM Coal Leachate	1E0	3E1	-	NH_3-N	L.N.	M	• Potentially hazardous according to SAM/1A evaluation. • Does not exceed RCRA EP Toxicity Concentrations.	• See runoff recommendations.
Clean Coal Leachate	3E0	3E1	-	-	L.N.	M		
Pond No. 1 Sediment	2E3	1E4	Sr,Cr,Mn, As,Ba,Pb, Li,Ni,P, Se,V	P,Mn	L.N.	N.C.	• Potentially hazardous according to SAM/1A evaluation. • Does not exceed RCRA EP Toxicity Concentrations.	• Further characterization during the Level 2 environmental assessment phase
Pond No. 1 Sediment Leachate	2E0	2E1	-	-	L.N.	M		
Pond No. 2 Sediment	6E2	3E3	Ba,Mn,Cr, Pb, Ni, P, Se	P	L.N.	-		
Pond No. 2 Sediment Leachate	2E0	1E1	-	NH_3-N	L.N.	M		
Pond No. 3 Sediment	8E2	3E3	Mn,As,Ba, Cd,Cr,Pb, Li,Ni,P, V	P,Mn	L.N.	N.C.		
Pond No. 3 Sediment Leachate	4E0	2E1	-	-	L.N.	M		

N.C. = Not conducted
L.N. = Low or Nondetectable
M = Moderate
* Bioassays conducted on the raw material.
EP Toxicity = Extraction Procedure Toxicity.

standards for TSP of 260 $\mu g/m^3$ and 150 $\mu g/m^3$, respectively) and 120 $\mu g/m^3$ for extractable organics. Particulate morphology tests showed that downwind particulates were primarily a quartz material rather than coal particles. Improved better dust suppression controls around coal handling areas could alleviate much of the high TSP loading. The bioassay tests for all fugitive sources were negative, consistent with the low TDS results.

1.4.3 Liquid Waste Streams

Liquid waste streams included sedimentation pond waters, coal and refuse pile runoffs, and plant feedwater. The health-based TDS values for trace elements were low with a range of 1-11. The TDS values for the ecological-based analyses were higher, ranging from 10-104. The major contributors to the ecological TDS values were ammonia, manganese, nickel, silver, and cadmium. All liquid streams were found to comply with applicable state effluent guidelines.

The total extractable organic concentrations ranged from 500 $\mu g/\ell$ to 3,300 $\mu g/\ell$. The highest organic values were measured in ROM coal pile runoff. There were no detectable concentrations of chromatographable organics in any liquid waste stream (i.e., TCO $<100\ \mu g/\ell$).

Bioassay tests generally agreed with the chemical analyses. The Ames tests were negative for all liquid streams and the health-related CHO clonal assay was nontoxic (i.e., median effective concentration (EC_{50}) $<$ 600 $\mu\ell/m\ell$) for feedwater and runoff. However, the CHO clonal assay had a moderate response to the pond waters with EC_{50} values of 63, 79, and 126 $\mu\ell/m\ell$ for the three pond waters. The pond waters were composited for aquatic bioassay testing and showed nondetectable effects on fish and invertebrates. The algal test, however, showed moderate effects with EC_{50} values of 63.0, 57.0, and 11.5 percent for 12-, 17- and 21-day exposure periods, respectively.

The need for control of pond waters is inconclusive since ecological-based TDS values were between 10 and 30, indicating a small to moderate potential for effect; the biological assessment tests showed some moderate biological response; and the chemical concentration of pollutants were below the applicable state effluent guidelines. Note that at preparation plant No. 1, the pond waters were part of a closed cycle system with no discharge to surface waters.

1.4.4 Solids and Leachates

Solid samples analyzed included ROM and clean coal, coarse and fine refuse, and pond sediments. Except for fine refuse (for which there was a slurry filtrate), a leachate was generated from each solid sample. The health-based, trace element TDS values for solids ranged from 540 to 2,400 with the highest values obtained for ponds No. 1 and 3 sediment. For pond No. 1 and the fine refuse, the high value was due to the presence of fine coal particles. Pond No. 3 receives runoff from the preparation plant and acid mine drainage, which would explain the higher TDS values than pond No. 2. In contrast, the health-based TDS for solids leachate were no higher than 4. The lower TDS values for leachates are partially due to the handling of elemental phosphorus. Phosphorus is known to be present in the form of phosphates in the liquid streams and was treated as such.

The ecological-based, trace element TDS values for solids ranged from about 3,100 to 10,000. In all cases the major contributor was phosphorus. The leachates produced much lower ecological TDS results with values ranging from 15 to 70, with ammonia the major contributor.

Total extractable organics in solids were only measured for pond sediments. The results, as expected, show a steady decline from 864 mg/g to 199 mg/g to 85 mg/g as the water overflows from the primary to secondary to tertiary ponds and fine coal particles settle out.

For leachates, only ROM coal leachate at 15,00 μg/ℓ and pond No. 1 sediment leachate at 2,300 μg/ℓ had total chromatographable organics plus gravimetric analysis (TCO + Grav) values above the detection limit of 1,000 μg/ℓ. Both leachate extractable organic concentrations were due to gravimetrically measured constituents.

Biological assessments of solids showed moderate effects from coarse refuse using the RAM assay and moderate effects on invertebrates and algae from the fine refuse slurry. The other 12 solid sample bioassays had low or nondetectable effects. For leachates, all health-based bioassays showed low or nondetectable effects. However, both the coal and coarse refuse leachates composite and the pond sediment composites had moderate effects on algae, but nondetectable effects on fish and invertebrates. The moderate effects on the algae were probably due to the high ammonia and trace metal concentrations. Future environmental assessments should be designed to verify this assumption. If the assumption is verified, then pH control technologies should be studied to determine their possible effectiveness for this application.

1.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1.5.1 Fugitive Emissions

Based upon the results from plant No. 1, there does not appear to be a fugitive dust problem at the plant boundaries. The results from this plant do not support the need for further study of fugitive air emissions during the level 2 environmental assessment phase.

1.5.2 Liquid Waste Streams

In all liquid waste streams, ammonia has a discharge severity value greater than one, on either a health or ecological basis. It is recommended that the protocol for analyzing ammonia be changed to include the use of standards for verification of results to determine if the ammonia is a result of interference during analysis or if the origin of ammonia is from coal mining activities.

Aluminum, cadmium, nickel, and silver also had discharge severity values greater than one in most liquid streams. The presence of these metals in the liquid waste streams is not unexpected as they are found in the coal. They are not produced during the preparation process. These results support the need for further characterization of liquid streams, during the level 2 environmental assessment phase.

1.5.3 Solids and Leachate Waste Streams

As expected, the pond sediments and fine waste solids contained heavy metals and other elements at concentrations that produce discharge severities ranging up to 10,000. These elements originate in the coal and the cleaning process is intended to produce refuse by removing incombustibles from the coal. The high concentrations of the elements emphasizes the concern over their ultimate disposal and that precautions must be taken to prevent the migration of these chemicals to the groundwater.

The leachates from the ROM coal, clean coal, and coarse refuse have considerably smaller potentials for problems based on ecological effects and little or no problem from the health standpoint. The results indicate that these leachates should be given relatively low priority during the level 2 environmental assessment phase.

The pond sediments leachates, however, show a higher potential for problems based on the ecological DMEG values and bioassay results. The sediment leachate chemical concentrations are much higher than the pond waters, which are in contact with the sediment. This is undoubtedly due to the pH of the pond water and dilution of the pond water by plant influent and precipitation. It is recommended that the EP method for testing leachability described in RCRA regulations, be used in future level 1 and 2 environmental assessments to investigate the leaching potential under acidic (i.e., worst case) conditions. It is also recommended that the pond sediments be further characterized during level 2 testing.

SECTION 2.0

COAL CLEANING PLANT DESCRIPTION

2.1 SURROUNDING AREA AND ENVIRONMENT

Coal preparation plant No. 1 is located in Kentucky in an area characterized by gently rolling terrain. The area has several small drainages that feed into a tributary of the Ohio River. The area is part of the Illinois-Indiana-Kentucky Basin, and is bordered on the east, south, and southwest by the Mississippi Plateau region.

The climate in this area is the humid continental type. The average annual temperature is 14°C (the average ranges from 2°C to 26°C), and the average annual precipitation is 112 cm, mostly as rain. The average annual evaporation is about 115 cm, yielding a net evaporation of 3 cm/yr.

The land surrounding the plant is mostly open fields and pasture land with small groves of hardwood trees. The soils in the area are silt loams and are generally well drained, although tile drainage systems have been installed in many areas. The soils are thick and exceed 25 m to bedrock in some places. Land use in the area is roughly 85 percent agricultural.

In addition to thick alluvial deposits in the floodplains of major rivers and their tributaries, layers of loess and gravel of Recent and Pleistocene age overlay consolidated rocks in the area. The consolidated rocks exposed in the area are sedimentary in origin. These Pennsylvanian-age rocks are mostly sandstone and shale with minor amounts of interbedded limestone and coal (Table 2-1).

Ground water in this region constitutes nearly 66 percent of all water pumped for public use, and 90 percent of this ground water is obtained from the consolidated rocks and the gravel/alluvium.

TABLE 2-1. STRATIGRAPHIC SECTION FOR COAL PREPARATION PLANT NO. 1 AREA

System	Series	Group	Formation	Member
Quaternary	Recent/Pleistocene		Union Formation Alluvium + Loess	
Quat./Tertiary	Pleistocene/Pliocene		Gravel	
Pennsylvanian	Missourian	McLeansboro Group	Henshaw Fm	Mt. Gilead Sandstone Mt. Gilead Shale Vanderburg Sandstone Bald Hill Shale Dixon Sandstone
			Lisman Fm	Carthage Limestone Madisonville Limestone *** Providence Limestone
			Carbondale Fm	*** Upper Sandstone Pleasantview(?) Sandstone *** Sebree Sandstone
			Tradewater Fm	*** Curlew Sandstone Unnamed Limestone Member Curlew Limestone Aberdeen Sandstone Finnie Sandstone Grindstaff Sandstone
			Caseyville Sandstone	Bee Springs Sandstone Lower Conglomerate

*** - Indicates location of coal deposits.

Wells drilled into the alluvium commonly yield 5-60 ℓ/sec. The only bedrock aquifers known to produce more than 5 ℓ/sec. are the Anvil Rock Sandstone and the Caseyville Sandstone. The average yields for these formations are 1.2 and (with much greater flows at different time intervals) and 6 ℓ/sec., respectively. Other formations yield less than 1 ℓ/sec.

Water pumped from the shallow bedrock aquifers is generally of the sodium bicarbonate or calcium bicarbonate type. This is replaced gradually by more sodium bicarbonate- or sodium chloride-type water in deeper aquifers. Saline water from deep aquifers is too highly mineralized for domestic use. Water from the bedrock is generally soft to moderately hard, but may contain considerable amounts of iron. Water pumped from the alluvium is generally the calcium bicarbonate type. The water is harder and usually contains more iron, but is suited for domestic use.

2.2 COAL CLEANING PLANT DESCRIPTION

A flowchart of the cleaning plant is provided as Figure 2-1. The plant capacity is rated at 450 kkg/h (i.e., 500 t/h). The plant processes coal from two deep mines in the area. Kentucky No. 11 coal, which is the predominate coal processed by the plant, is extracted at a nearby mine and is fed to an above-ground coal pile in the vicinity of the cleaning plant. Kentucky No. 9 coal is mined at another nearby camp mine and delivered by coal truck and conveyor. From the piles, the coal is transferred via a stacker/reclaimer to a presizing raw coal screen where the plus 12.5 cm (5 in.) material is directed to a rotary breaker. The underflow from this screen is blended into the product from the rotary breaker. The breaker processes the coal to a 12.5 cm top size and rejects the coarse rock and refuse. The raw coal is then conveyed to a fixed grizzly screen with a tramp iron magnet for removal of rocks and scrap iron. The raw coal is weighed using a weigh belt conveyor and sent to a pre-wet 0.48 cm (3/16 in.) raw coal sizing screen.

The overflow from the raw coal screen consists of 12.5 x 0.48 cm (5 x 3/16 in.) coal that flows to a water-pulsed, dual-compartment Baum jig. The jig produces two product streams: a coarse and a middling fraction, and a refuse stream. The coarse size clean coal stream is

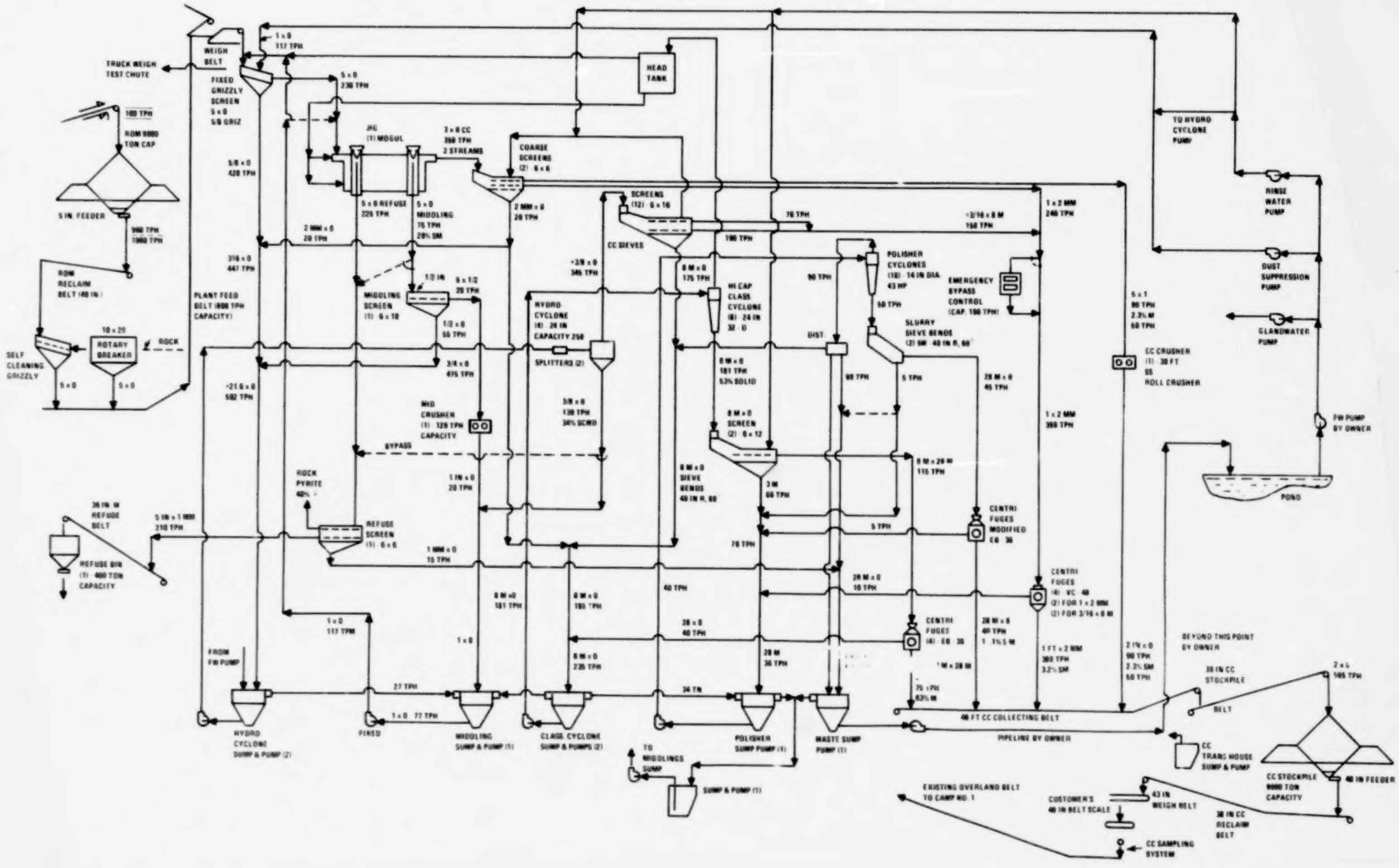

TRUCK WEIGH TEST CHUTE
WEIGH BELT
FIXED GRIZZLY SCREEN 5 x 0 5/8 GRIZ
1 x 0 117 TPH
5 x 0 230 TPH
100 TPH
ROM 9000 TON CAP
5 IN. FEEDER
960 TPH 1960 TPH
ROM RECLAIM BELT (48 IN.)
SELF CLEANING GRIZZLY
10 x 20 ROTARY BREAKER
ROCK
5 x 0
5 x 0
5/8 x 0 420 TPH
3/16 x 0 447 TPH
PLANT FEED BELT (800 TPH CAPACITY)
+21.6 x 0 502 TPH
JIG (1) MOGUL
3 x 8 CC 290 TPH 2 STREAMS
5 x 0 REFUSE 225 TPH
5 x 0 MIDDLING 75 TPH 29% SM
2 MM x 0 20 TPH
COARSE SCREENS (2) 6 x 6
2 MM x 0 20 TPH
HEAD TANK
MIDDLING SCREEN (1) 6 x 10
1/2 IN
6 x 1/2 20 TPH
1/2 x 0 55 TPH
3/4 x 0 475 TPH
MID CRUSHER (1) 125 TPH CAPACITY
BYPASS
1 IN x 0 20 TPH
ROCK PYRITE 40% -
REFUSE SCREEN (1) 6 x 6
1 MM x 0 15 TPH
36 IN. W REFUSE BELT
5 IN x 1 MM 210 TPH
REFUSE BIN (1) 400 TON CAPACITY
HYDRO CYCLONE (4) 28 IN CAPACITY 250
SPLITTERS (2)
+3/8 x 0 345 TPH
3/8 x 0 139 TPH 34% SCWD
SCREENS (12) 6 x 16
CC SIEVES
78 TPH
198 TPH
8 M x 0 175 TPH
HI CAP CLASS CYCLONE (8) 24 IN 32 · D
8 M x 0 181 TPH 53% SOLID
8 M x 0 SCREEN (2) 6 x 12
8 M x 0 SIEVE BENDS 40 IN R, 60
3 M 66 TPH
78 TPH
40 TPH
8 M x 0 181 TPH
8 M x 0 185 TPH
28 x 0 40 TPH
8 M x 0 235 TPH
28 M 38 TPH
34 TN
1 x 0
1 x 0 117 TPH
1 x 0 77 TPH
27 TPH
FROM FW PUMP
FIXED
HYDRO CYCLONE SUMP & PUMP (2)
MIDDLING SUMP & PUMP (1)
CLASS. CYCLONE SUMP & PUMPS (2)
POLISHER SUMP PUMP (1)
WASTE SUMP PUMP (1)
TO MIDDLINGS SUMP
SUMP & PUMP (1)
90 TPH
DIST.
POLISHER CYCLONES (18) 14 IN DIA 43 HP
50 TPH
SLURRY SIEVE BENDS (2) SM 40 IN R, 60°
60 TPH
5 TPH
28 M x 0 45 TPH
8 M x 28 M 115 TPH
5 TPH
CENTRI FUGES MODIFIED EB 36
28 M x 0 10 TPH
CENTRI FUGES (4) EB 36
28 M x 8 40 TPH 1 · 1½ S M
1 M x 28 M
75 TPH 63% M
EMERGENCY BYPASS CONTROL (CAP. 190 TPH)
1 x 2 MM 240 TPH
+3/16 x 8 M 150 TPH
1 x 2 MM 390 TPH
CENTRI FUGES (4) VC 48 (2) FOR 1 x 2 MM (2) FOR 3/16 x 8 M
1 FT x 2 MM 380 TPH 3.2% SM
5 x 1 90 TPH 2.3% M 50 TPH
CC CRUSHER (1) 30 FT SS ROLL CRUSHER
2 1/2 x 0 90 TPH 2.3% SM 50 TPH
48 FT CC COLLECTING BELT
PIPELINE BY OWNER
BEYOND THIS POINT BY OWNER
36 IN CC STOCKPILE
BELT
2 x 6 105 TPH
CC TRANS HOUSE SUMP & PUMP
CC STOCKPILE 9000 TON CAPACITY
48 IN FEEDER
36 IN CC RECLAIM BELT
43 IN WEIGH BELT
CUSTOMER'S 48 IN BELT SCALE
CC SAMPLING SYSTEM
EXISTING OVERLAND BELT TO CAMP NO. 1
TO HYDRO CYCLONE PUMP
RINSE WATER PUMP
DUST SUPPRESSION PUMP
GLANDWATER PUMP
FW PUMP BY OWNER
POND

FIGURE 2–1. FLOW CHART FOR COAL PREPARATION PLANT NO. 1.

dewatered on a double deck screen. The overflow from the top deck of the screen is subsequently crushed to a 5 cm (2 in.) top size and sent to the clean coal load-out belt. The overflow from the second screen deck, which consists of finer sized coal (i.e., 25 x 2 mm), is dewatered in a coarse coal centrifuge and sent to the clean coal load-out belt.

The intermediate product from the jig, called the middlings, is separated into two size fractions on the middling dewatering screen. The screen overflow, consisting of 7.6 x 1.3 cm (3 x 1/2 in.) coal, is crushed to a 2.5 cm (1 in.) top-size, and blended with the middlings screen overflow and the underflow from the raw coal sizing screens. This coal slurry is pumped to a bank of 61 cm (24 in.) diameter hydrocyclones for further cleaning. The clean coal from the hydrocyclones is dewatered on a screen, then in a centrifuge, and is finally sent to the clean coal load-out belt. The underflow from the hydrocyclone circuit is recycled to the middlings sump for further processing.

The fine coal circuit in the plant is basically a recovery circuit which contains the screen underflows from the clean coal dewatering screen in the jig circuit and from the dewatering screen in the hydrocyclone circuit. The fine coal slurry is collected in a sump and pumped to a bank of classifying cyclones for thickening. The thickened fine coal slurry is dewatered first on a sieve bend, then by dewatering screens, and finally in a centrifuge. The centrifuge cake is sent to the clean coal load-out belt. The underflow from the fine coal dewatering screen is collected in a polisher sump along with centrate from several dewatering centrifuges. This fine coal slurry is pumped to a bank of 25 cm (10 in.) diameter classifying cyclones to recover additional product. The underflow from the classifying cyclones is dewatered on screens by a fine coal centrifuge and then is sent to the clean coal load-out belt.

The refuse streams in the plant consist of:

- Coarse refuse from the Baum jig which is dewatered on screens and sent to the coarse refuse pile.
- Fine refuse collected in a sump from the overflows of the polishing cyclones.

The plant has the flexibility to include underflow from the slurry sieve bends in this fine refuse sump. The fine refuse slurry collected in the sump is pumped to a series of settling ponds. Refuse handling is discussed in Section 2.3.

2.3 AUXILIARY FACILITIES

As shown in Figure 2-2, the auxiliary facilities consist of the ROM storage piles for Kentucky No. 9 and No. 11 coals, the clean coal storage area and sampling system, the three fine refuse settling ponds, the coarse refuse bin, and the coarse refuse pile.

2.3.1 ROM Storage

Coal preparation plant No. 1 is served by two separate ROM coal handling facilities. The Kentucky No. 9 ROM coal facility receives coal from an underground mine using conventional continuous mining equipment. The coal is transported to the cleaning plant using an underground conveying system and coal trucks. At the plant the coal proceeds through the tipple (i.e., transfer facility) southeast of the main cleaning plant, is conveyed to a stacker/reclaimer tower, and piled for subsequent transfer to the preparation plant. From the ROM coal pile, the Kentucky No. 9 coal goes through a second transfer facility to the rotary breaker for entry into the plant.

The Kentucky No. 11 coal is obtained from the mine for which the coal preparation facility was originally built. The tipple for this mine is west of the cleaning plant. From the tipple, the coal is conveyed to the Kentucky No. 11 stacker/reclaimer, which is southwest of the cleaning plant and adjacent to the rotary breaker. The Kentucky No. 11 coal is fed directly to the rotary breaker conveyor without the need for a transfer facility.

2.3.2 Clean Coal Storage Area and Sampling System

Clean coal is taken from the preparation plant through a series of two conveyors northeast of the cleaning plant. The clean coal is piled atop a 10 m hill adjacent to the plant access road. From this pile the coal is conveyed through three small transfer stations to a clean coal

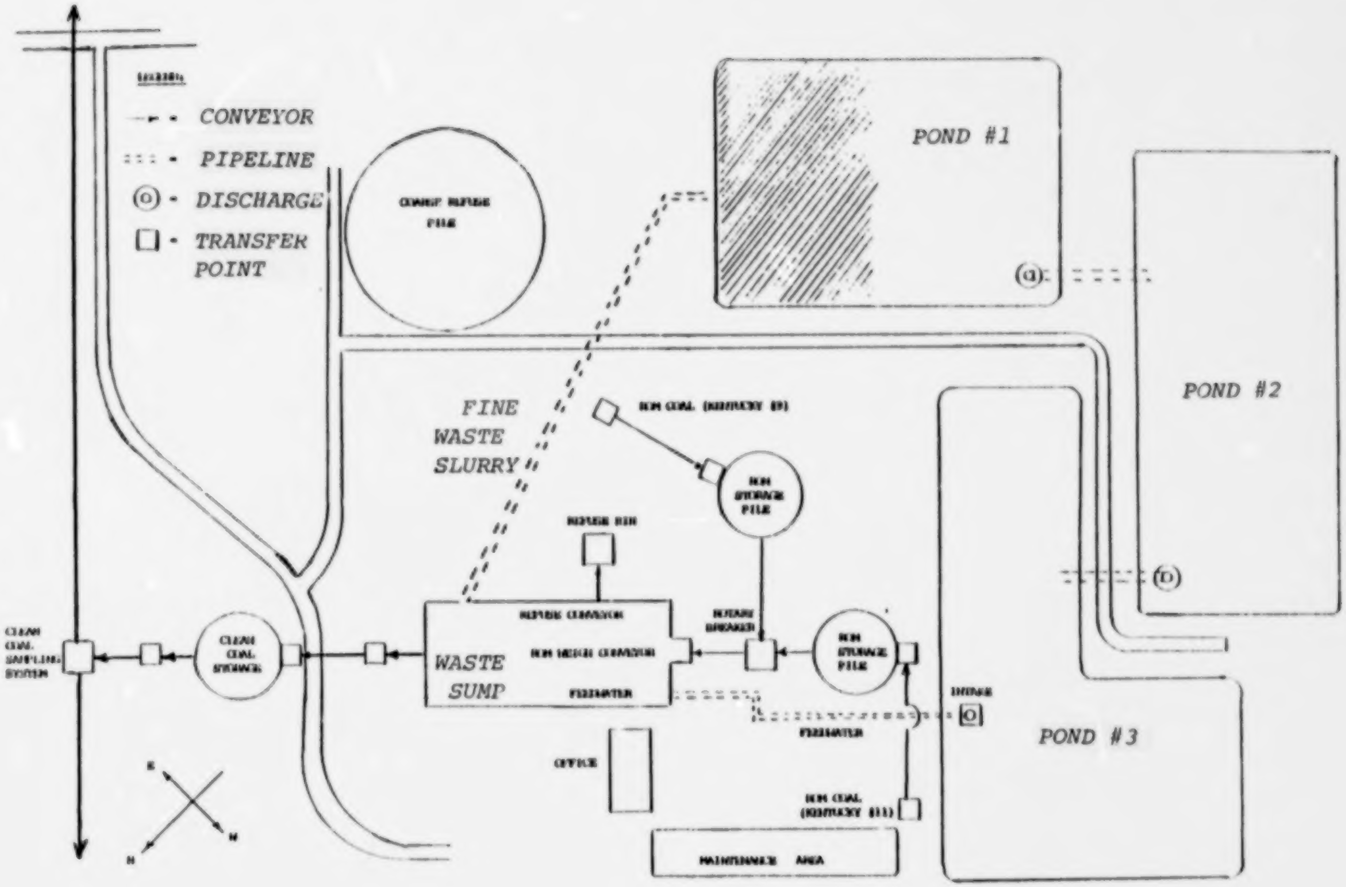

LEGEND
CONVEYOR
PIPELINE
DISCHARGE
TRANSFER POINT
POND #1
POND #2
POND #3
(a)
(b)
FINE WASTE SLURRY
WASTE SUMP
REFUSE CONVEYOR
FEEDWATER
REFUSE BIN
ROTARY BREAKER
ROM STORAGE PILE
ROM STORAGE PILE
ROM COAL (KENTUCKY #9)
ROM COAL (KENTUCKY #11)
INTAKE
OFFICE
MAINTENANCE AREA
CLEAN COAL STORAGE
CLEAN COAL SAMPLING SYSTEM
N
N

Figure 2-2. Plot plan for coal preparation plant No. 1.

automatic sampling device. This device takes representative cuts (i.e., samples) of the clean coal for subsequent coal analysis. This sampling equipment was used for taking representative samples of clean coal during the environmental assessment. The clean coal system is common for both Kentucky No. 9 and No. 11 coals.

From the clean coal sampling system, the coal is transferred to river barges through a 1 km long conveyor that is parallel to the plant access road.

2.3.3 Fine Refuse Settling Ponds

Coal preparation plant No. 1 uses three fine refuse (i.e., black water) ponds in series to clarify slurry water and to maintain a closed water system. There is no point source effluent from these ponds.

Pond No. 1 receives fine refuse slurry directly from the waste sump located in the main preparation building. The slurry pipeline is situated underground until it reaches the slurry pond. This pond is located about 0.5 km south of the preparation plant. The pond is about 1 m deep and 2 ha (5 acres) in surface area. Runoff to this pond is small. After approximately two years of operation, the pond has become 70 percent filled with fine refuse. Water from pond No. 1 overflows through a trash rack and circular outfall to pond No. 2. The outfall height can be adjusted to control the depth of the pond.

Pond No. 2 is a rectangular pond which provides detention time for fine refuse slurry water to clarify completely. The pond is about 1 m south-southeast of the plant and receives some area runoff in addition to the slurry water. This pond is also about 2 ha in area and 1-2 m deep. Again, a trash rack/circular outfall is used to transfer water between ponds.

Pond No. 3 receives clarified water from pond No. 2. Most coal preparation plant runoff is diverted to this pond, in addition to acid mine drainage from the mine adjacent to the plant. Pond No. 3 is the largest of the three ponds with a surface area of about 4 ha and a depth of 2 m. Coal preparation plant No. 1 makeup water is taken from this pond, which is 0.5 m southeast of the plant.

SECTION 3.0

SAMPLING METHODOLOGY

Twenty-five process and waste streams were sampled during the coal preparation test program. Presented in this section is a description of each sampling point and the sampling methods employed.

3.1 FUGITIVE EMISSIONS (PARTICULATE AND VAPOR)

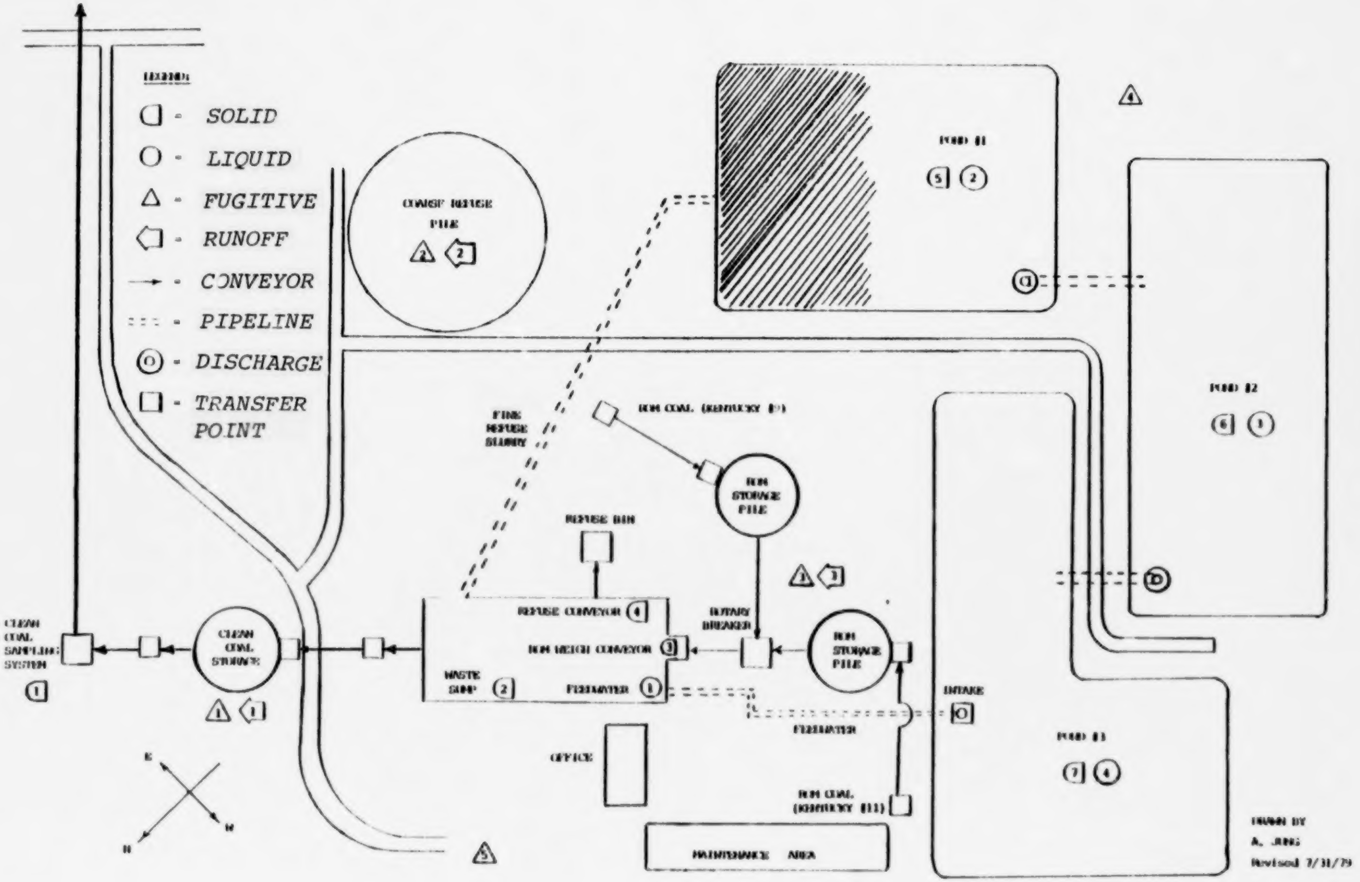
3.1.1 Sampling Point Locations

Fugitive emissions were sampled at the following locations:

- Downwind of clean coal pile.
- Downwind of coarse refuse pile.
- Downwind of ROM coal pile.
- Downwind of plant facility.
- Upwind of the site.

Figure 3-1 indicates the approximate locations of the fugitive sampling sites represented by the triangles on the sketch. The particulates and vapor samples collected at these locations were analyzed for the chemical and biological parameters shown in parts 3 and 4 of Table 3-1.

Fugitive emissions are best sampled downwind of their source at a location where the particulates are calculated to have settled to near ground level. The chosen sampling location was,therefore, dependent on such variables as wind velocity and physical dimensions of the source itself. Overall site emissions were sampled using the upwind/downwind technique. This technique utilizes samplers to determine the background concentrations (including the background and any point source contributions) upwind of the site. The total fugitive emissions from the site are then calculated by subtracting the measured background and point source concentrations from the measured total pollutants. Note that this coal cleaning plant has no point source air emissions.



LEGEND
SOLID
LIQUID
FUGITIVE
RUNOFF
CONVEYOR
PIPELINE
DISCHARGE
TRANSFER POINT
COARSE REFUSE PILE
POND #1
POND #2
POND #3
FINE REFUSE SLURRY
ROM COAL (KENTUCKY #9)
ROM STORAGE PILE
REFUSE BIN
REFUSE CONVEYOR
ROM WEIGH CONVEYOR
WASTE SUMP
FEEDWATER
ROTARY BREAKER
INTAKE
OFFICE
ROM COAL (KENTUCKY #11)
MAINTENANCE AREA
CLEAN COAL STORAGE
CLEAN COAL SAMPLING SYSTEM
DRAWN BY
A. JUNG
Revised 7/31/79

Figure 3-1. Final sampling sites for coal preparation plant No. 1.

TABLE 3-1. LEVEL 1 SAMPLING AND ANALYSIS PLAN
FOR COAL PREPARATION PLANT NO. 1

	ELEMENTAL (SSMS)[1]	Hg (AAS)[2]	COAL[3]	WATER QUAL. TESTS[4]	ANIONS[5]	PARTICULATE MORPHOLOGY[6]	ORGANIC-LC, LRMS[7]	ORGANIC-GC/MS[8]	ORGANIC-LC, GC/MS[9]	MUTAGENESIS (AMES)[10]	CYTOTOXICITY-RAM[11]	CYTOTOXICITY-CHO[12]	AQUATIC BIOASSAY[13]
1 Solids													
1. Clean Coal	X	X	X							X	X		
2. Waste Sump (filtered)	X	X	X							X	X		
3. ROM Coal	X	X	X							X	X		
4. Coarse Refuse	X	X	X							X	X		
5. Pond #1 Sediment	X	X					X	(X)		X	X		
6. Pond #2 Sediment	X	X					X	(X)		X	X		
7. Pond #3 Sediment	X	X					X	(X)		X	X		
2 Liquids													
1. Feedwater (filtrate)	X	X		X	X					X		X	
2. Waste Sump (filtrate)	X	X		X	X		X	(X)	(X)	X		X	X
3. Pond #1	X	X		X	X		X	(X)		X		X	X
4. Pond #2	X	X		X	X		X	(X)		X		X	X
5. Pond #3	X	X		X	X		X	(X)		X		X	X
3 Fugitive Dusts													
1. Clean Coal Storage	X	X				X				X	X		
2. Coarse Refuse Pile	X	X				X				X	X		
3. ROM Storage Pile	X	X				X				X	X		
4. Upwind	X	X				X				X			
5. Downwind	X	X				X				X	X		
4 Organic Vapors (XAD-2)													
1. Clean Coal Storage	X	X					X	(X)		X			
2. Coarse Refuse Pile	X	X					X	(X)		X			
3. ROM Storage Pile	X	X					X	(X)		X			
4. Upwind	X	X					X	(X)		X			
5. Downwind	X	X					X	(X)		X			
5 Runoff													
1. Clean Coal Storage	X	X		X	X		X	(X)	(X)	X		X	
2. Coarse Refuse Pile	X	X		X	X		X	(X)		X		X	
3. ROM Storage Pile	X	X		X	X		X	(X)	(X)	X		X	
6 Leachates													
1. Clean Coal	X	X		X	X		X	(X)		X		X	X
2. ROM Coal	X	X		X	X		X	(X)		X		X	X
3. Coarse Refuse	X	X		X	X		X	(X)		X		X	X
4. Pond #1 Sediment	X	X		X	X		X	(X)		X		X	X
5. Pond #2 Sediment	X	X		X	X		X	(X)		X		X	X
6. Pond #3 Sediment	X	X		X	X		X	(X)		X		X	X

Parenthesis indicate further analysis if high organic concentrations were found.

TABLE 3-1. (CONTINUED)

NOTES

1. Elemental (SSMS) - Spark Source Mass Spectrometry.
2. Hg (AAS) - Mercury by Atomic Absorption Spectrophotometry.
3. Coal - (Ultimate & Proximate) - Moisture, Ash, Volatiles, Sulfur, Btu, Fixed and Total Carbon, Hydrogen, Nitrogen, Chlorine.
4. Water Quality Tests - Temperature, Dissolved Oxygen (D.O.), Conductivity, Chlorine, Ammonia, pH, Sulfide, Carbonate, Alkalinity, Acidity, Cyanide, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Hardness.
5. Anion - Sulfate, Chloride, Phosphate, Bromide, Nitrite, Nitrate, Sulfide.
6. Particulate Morphology - Size distribution, Gravimetric, Photomicroscopy.
7. Organic-LC,LRMS - Liquid Chromatography, Low Resolution Mass Spectrometry.
8. Organic-GC/MS - Gas Chromatography/Mass Spectrometry.
9. Organic-LC,GC/MS - 7 and 8 combined.
10. Mutagenesis (AMES) - Salmonella/Microsome Mutagenesis Assay.
11. Cytotoxicity-RAM - Rabbit Alveolar Macrophage Assay.
12. Cytotoxicity-CHO - Chinese Hampster Ovary Assay.
13. Aquatic Bioassay - Algal, Fish, and Invertebrate Bioassays.

Measurements of predominant wind velocity and direction were made before sampling. Surface wind speed, direction, and cloud cover were used to determine the horizontal and vertical dispersion coefficients.(1) Samplers to characterize fugitives from the entire facility were located no closer than 0.5 km to the nearest source. Upwind samples were collected at a point no closer than 0.5 km to the nearest cleaning plant source and away from any sources which would bias the collection of ambient particulates.

Once samplers were installed at downwind locations, sampling continued for 24 hours. A sampling rate of 1.12 m^3/min (40 ft^3/min) was used. Shifts in wind direction necessitated moving the samplers, and sampling was not conducted during periods of precipitation. Table 3-2 details the locations of each sampler, total sampling time, volume of air sampled for total particulates, and volume of air sampled for vapors.

TABLE 3-2. FUGITIVE EMISSION SAMPLING DATA

Source	Distance of Sample from Source (m)	Sampling Time (Hrs.)	Volume of Air (m^3) Particulates	Sampled Vapor
Clean Coal Pile	200	13.00	873.6	79.6
Coarse Refuse Pile	300	10.15	682.1	59.7
ROM Coal Pile	300	13.00	884.5	75.7
Upwind of Facility	600	18.20	1,223	107.0
Downwind of Facility	500	17.70	1,189.4	108.3

3.1.2 Sampling Description and Requirement

Particulate emissions and vapors were collected using two high volume (Hi-Vol) air samplers at each location (Sierra Model UV-1 flow-controlled high volume sampling system). The Hi-Vol dedicated for total particulates had an effective filter sample area of 406.5 cm^2. This sampler was modified so that, in addition to collecting total particulates, vapors were collected concurrently from a side stream that passed through a cartridge containing 125 g of XAD-2 sorbent resin (see Figure 3-2). The sidestream vacuum pump and rotometer were housed in a separate shelter placed in close proximity to the Hi-Vol.

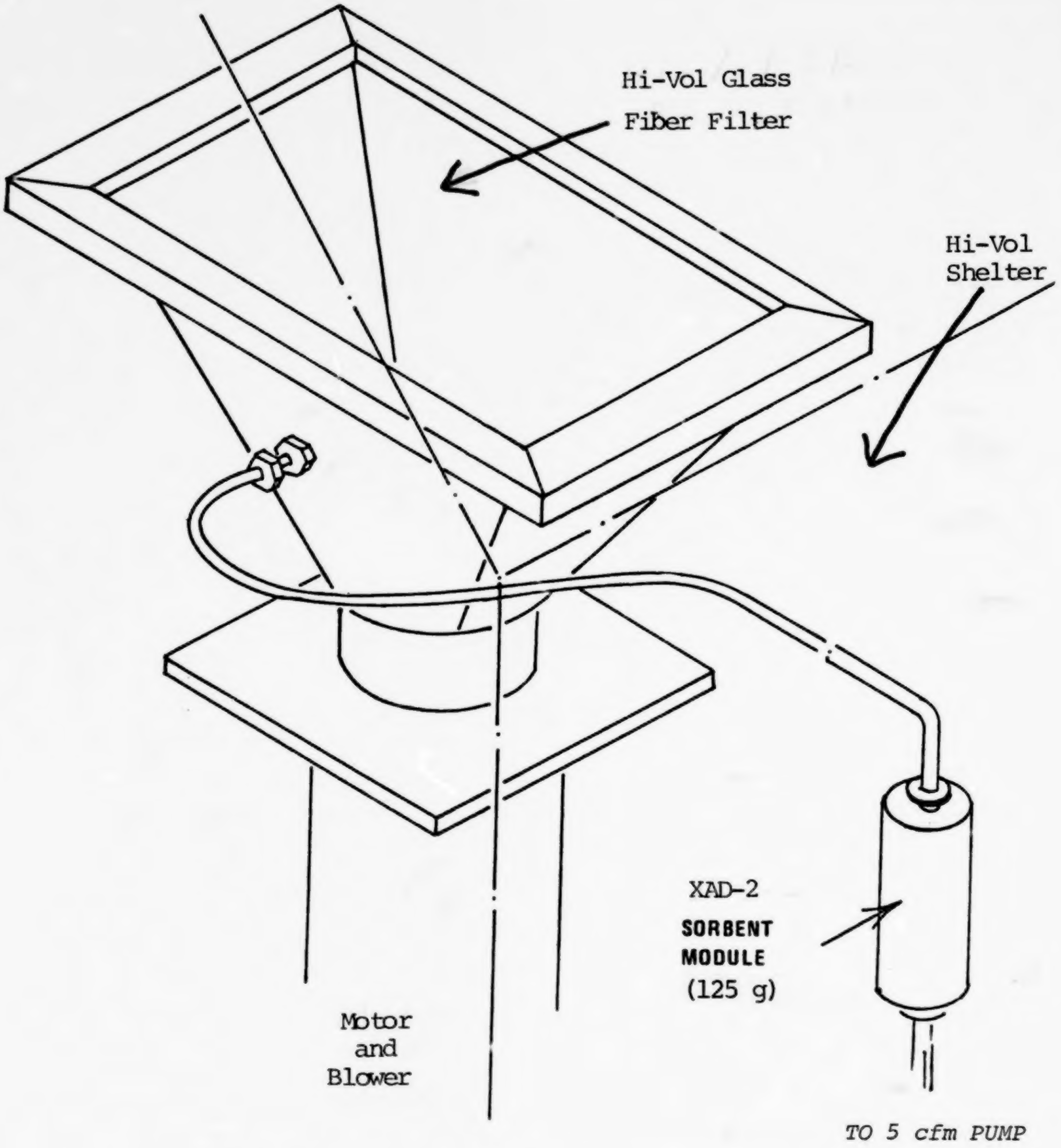

Hi-Vol Glass
Fiber Filter
Hi-Vol
Shelter
XAD-2
SORBENT
MODULE
(125 g)
Motor
and
Blower
TO 5 cfm PUMP

Figure 3-2. Modified Fugitive Emissions Sampler.

The other Hi-Vol was positioned 15 m from the first Hi-Vol and fitted with a five-stage Cascade impactor (Sierra Model 235), Figure 3-3.

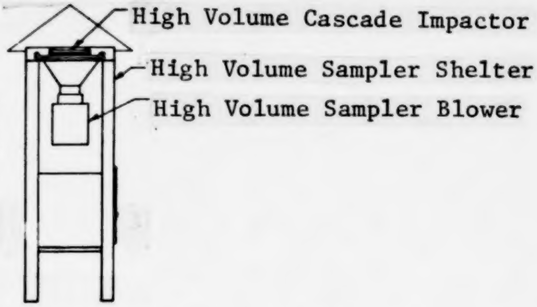

High Volume Cascade Impactor
High Volume Sampler Shelter
High Volume Sampler Blower

Figure 3-3. Hi-Vol sampler with Cascade impactor.

The Cascade impactor is based on a slotted design in which the suspended particulates enter the impactor through parallel slots in the first stage, and particles larger than the particle cut-off size of the first stage impact on the slotted collection substrate. Figure 3-4 illustrates this design.

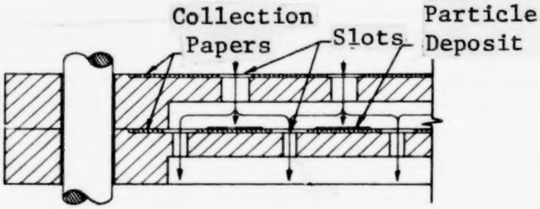


Figure 3-4. Cross-section of Cascade impactor.

The air stream then passes through the slots in the collection substrate, accelerates through narrower slots in the second impactor stage, and the remaining particles greater than the particle cut-off size of the second stage impact on the second collection substrate, etc. The width of the stage, and most of the smaller particles eventually acquire sufficient momentum to impact on one of the collection substrates. After the last impactor stage, the remaining fine particles are collected by the backup filter in the high volume sampler. The collection substrates and backup filter were weighed before and after sampling to determine the particle size distribution. The particle size cut-offs in micrometers are given in Table 3-3.

TABLE 3-3. PARTICLE SIZE DISTRIBUTION FOR THE CASCADE IMPACTOR

Stage No.	Particle Top Size (micrometers)*
1	7.2
2	3.0
3	1.5
4	0.95
5	0.49
Backup Filter	0

*Particle size distribution (micrometers) at 1.12 m^3/min flowrate, 50 percent collection efficiency for spherical particles with unity mass density @ 25°C and 760 mm Hg.

Power was supplied to the Hi-Vol samplers and sidestream vacuum pump using a 3500 watt, gasoline-powered, portable generator. The generator was positioned 50 m downwind of the samplers so that the exhaust gases would not contaminate the sample.

3.2 STACK EMISSIONS (PARTICULATE AND GASEOUS)

No stacks were in use at this coal preparation plant.

3.3 LIQUIDS

3.3.1 Sampling Point Location

Bulk liquids, storage pile runoff, and leachates from selected solids include the following:

- Filtrate from plant feedwater.
- Filtrate from fine refuse slurry.
- Filtered water from desilting ponds Nos. 1, 2, and 3.
- Runoff from clean coal storage pile.
- Runoff from coarse refuse pile.
- Runoff from ROM coal storage pile.
- Clean coal leachate.

- ROM coal leachate.
- Coarse refuse leachate.
- Leachate from bottom sediment of desilting ponds Nos. 1, 2, and 3.

Figure 3-1 indicates the approximate locations where liquid samples were collected as shown by the circular symbols. Runoff samples collected around the perimeter of various storage piles are indicated by the arrow symbols. Section 2, 5, and 6 in Table 3-1 details the types of analyses which were conducted on these samples.

3.3.2 Sampling Description and Equipment

The volumes of aqueous liquid/slurry samples required for chemical and biological analyses are as follows:

- Organic extraction/analysis - 10 ℓ
- Health effects tests and aquatic bioassay - 42 ℓ
- Laboratory analysis - 2 ℓ
- Field analysis - 1 ℓ

The feedwater sample was collected from a pipe located on the ground level of the plant. The water was allowed to run for 15 minutes before the appropriate quantity of samples was collected. The fine refuse slurry sample was also collected on the ground level of the plant from a sample tap beneath the waste sump. Forty liters of slurry were drawn off and discarded before the actual sample was collected.

Pond water samples were collected from the overflow structures of ponds No. 1 and 2 and from the feedwater intake structure of pond No. 3. A diaphragm hand pump was used to transfer the pond water to appropriate containers. The intake hose of the pump was placed 15 cm below the surface to avoid potential contamination. Pond water was pumped for five minutes to purge any contaminants from the pump and hose before the sample was collected.

Stormwater runoff samples were collected from the clean coal, coarse refuse, and ROM coal storage piles using runoff plug collectors (Figure 3-5).

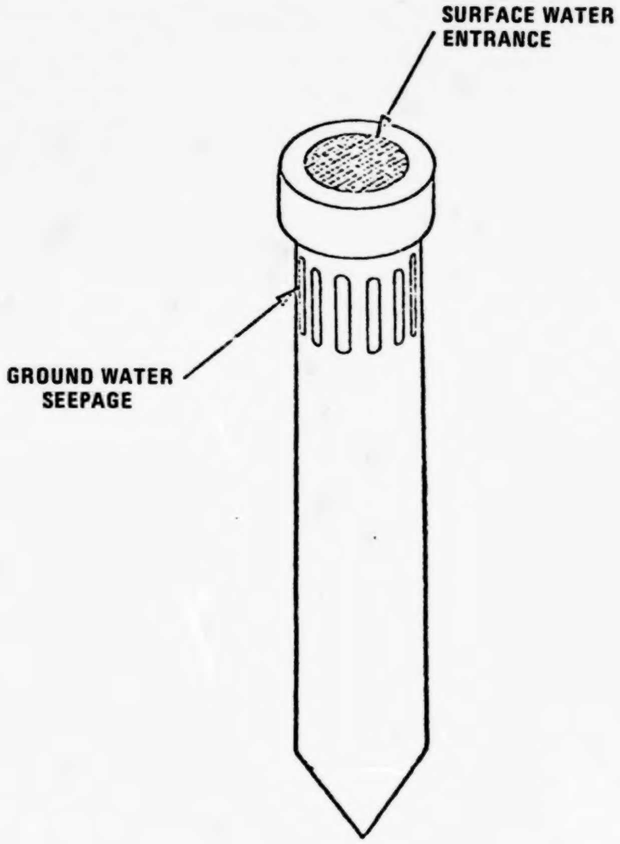


Figure 3-5. Stormwater runoff plug collectors.

A minimum of eight of these collectors were placed around the perimeter of each pile on the first day of sampling. Using earth augers, holes were drilled in natural depressions and erosion ditches so that runoff could be collected after a precipitation event. The collectors remained at these locations until the seventh sampling day when a rain shower produced sufficient runoff to yield a sample. The contents of each collector were combined to produce a runoff composite for each pile.

All liquid samples, that is feedwater, fine waste slurry, pond water, and runoff, were split immediately after collection into aliquots for field and laboratory analyses. Forty-two liters of unfiltered sample were contained, packed in insulated shipping crates, iced, and air freighted to the biological testing laboratory. Two one liter containers were filled with unfiltered samples, preserved, and air freighted to the analytical laboratory.

Two additional 1000 mℓ aliquots were filtered through 47 mm glass fiber filters, and the filters were retained for elemental and mercury analyses. The balance of the water samples were filtered through 18.5 cm Buchner funnels with Whatman 41 filter paper. Ten liters of the filtrate were extracted at pH 2 and pH 10 with methylene chloride. The acidic and basic extracts were retained for organic analysis, and the aqueous layer was discarded. Field water quality analyses using portable test kits were initiated immediately on a one liter aliquot of the filtrate.

Aqueous leachates were prepared in the laboratory from bulk solids, including samples of clean coal, ROM coal, coarse refuse,and sediment from the three ponds. Leachates were prepared by shaking a known weight of solid with deionized water in a ratio of 1 mg of solid to 4 mℓ of water for 48 hours. The aqueous phase was then separated by filtration and analyzed.

3.4 SOLIDS

3.4.1 Sampling Point Leachates

Coal, refuse, and solid samples include the following:

- Clean coal from conveyor leaving the preparation plant.
- Filtered solids of fine refuse from a sample tap on the waste sump.
- ROM coal from the weigh conveyor.
- Coarse refuse from the refuse bin conveyor.
- Dewatered sediment from desilting ponds No. 1, 2, and 3.

The approximate locations of the solid sampling points are indicated on Figure 3-1. Section 1 of Table 3-1, lists the types of analyses which were performed on each of these samples.

3.4.2 Sample Description and Equipment

A clean coal sample was taken from the transfer hopper on the conveyor leaving the plant. Cross-stream cuts were taken with a coal shovel and placed into two polyethylene bag lined 5-gallon pails. The liners were sealed to prevent moisture loss and possible sample oxidation and shipped to the laboratory for pre-analysis preparation.

Fine waste solids were obtained from the filtration process of the fine waste slurry as described in Section 3.3.

A ROM coal sample was obtained by taking cross-stream cuts at the weigh conveyor. The coal was placed in two 5-gallon containers, and the liner was sealed.

Coarse refuse was collected from the conveyor transporting the material from the plant to the loading hopper outside the plant. Cross-stream cuts were taken and two 5-gallon pails were filled with sample material and sealed.

Pond sediment samples were collected at eight locations around the perimeter of each pond at equal depths, using a brass Ekman dredge. The Ekman dredge used for Level 1 Environmental Assessments does not account for vertical size distribution of the sediments. A core sample of the pond sediments to provide detailed analyses is required for Level 2 Environmental Assessments. The individual aliquots were combined and homogenized to produce a composite sediment sample for each of the three ponds. Each composite was split into separate analytical samples. The 10 kg aliquot for biological assay testing was immediately containerized, iced for shipment, and air-freighted to the biological testing laboratory.

Prior to analysis the ROM coal, clean coal, and coarse refuse samples were spread out on polyethylene sheets and allowed to air dry overnight. All material was reduced to 0.63 cm x 0 top size using a jaw crusher. Aliquots for leachate preparation were withdrawn from the crushed sample, containerized, and shipped to the laboratory. The remaining crushed material was ground to minus 60 mesh using a rotary pulverizer, and the material retained for analysis.

SECTION 4.0

ANALYTICAL PROCEDURES

Both chemical (inorganic and organic) and biological analyses were performed on the samples obtained from coal preparation plant No. 1. Figures 4-1 through 4-5 show the analytical scheme used for each type of sample.

The following subsections contain detailed descriptions of the sample extraction procedures and the analytical methodologies used. The water quality, inorganic, and organic analyses are described in Sections 4.1.1, 4.1.2, and 4.1.3, respectively, and the bioassay tests are described in Section 4.2.

All chemical analyses were performed exactly as specified in the IERL-RTP Level 1 Environmental Assessment procedures. Detail is provided to facilitate understanding of analytical procedures and for comparison with other data.

4.1 INORGANIC AND ORGANIC SPECIES ANALYSES

Inorganic analyses were performed on all wastes from the coal preparation plant. The solid fugitive air emission samples were analyzed by Spark Source Mass Spectrophotometry (SSMS), and all liquid samples were analyzed by both SSMS and by Inductively Coupled Argon Plasma Optical Emission Spectroscopy (ICP-OES) for metals. The inorganic analyses were performed by Commercial Testing and Engineering Company (CT&E), and also by Versar's laboratories in Springfield, Virginia.

Organic analyses were performed on pond water, pond sediment, pond sediment leachate, coal leachate, and fugitive gases. The analysis consisted of Total Chromatographable Organics (TCO) and Gravimetric (GRAV) determinations of sample extracts. The samples were analyzed for total organic content. Individual organic compounds contained in each sample were not identified.

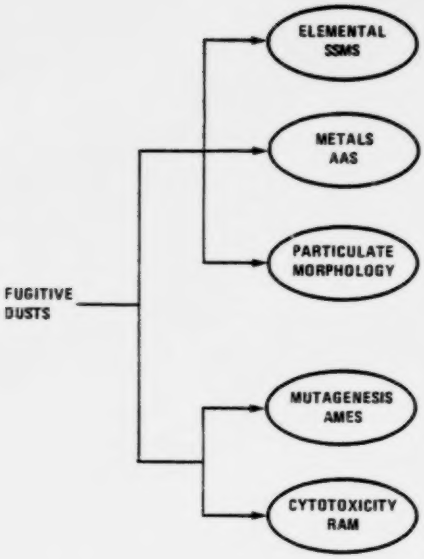

ELEMENTAL
SSMS
METALS
AAS
PARTICULATE
MORPHOLOGY
FUGITIVE
DUSTS
MUTAGENESIS
AMES
CYTOTOXICITY
RAM

FIGURE 4-1 ANALYTICAL FLOW SCHEME FOR DUST SAMPLES

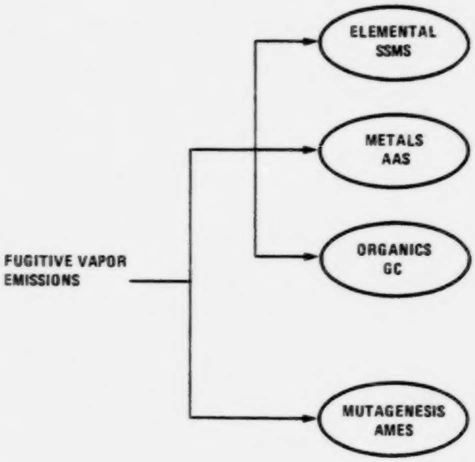
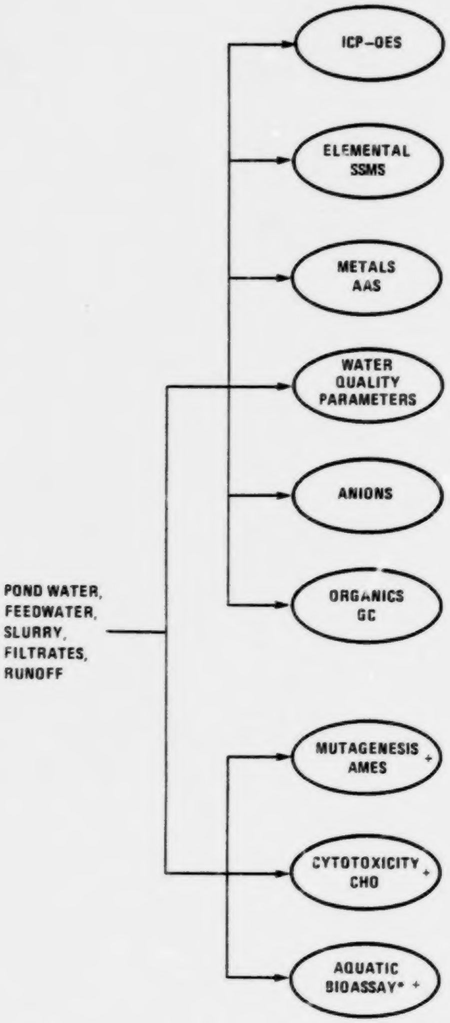

ELEMENTAL
SSMS
METALS
AAS
ORGANICS
GC
FUGITIVE VAPOR
EMISSIONS
MUTAGENESIS
AMES

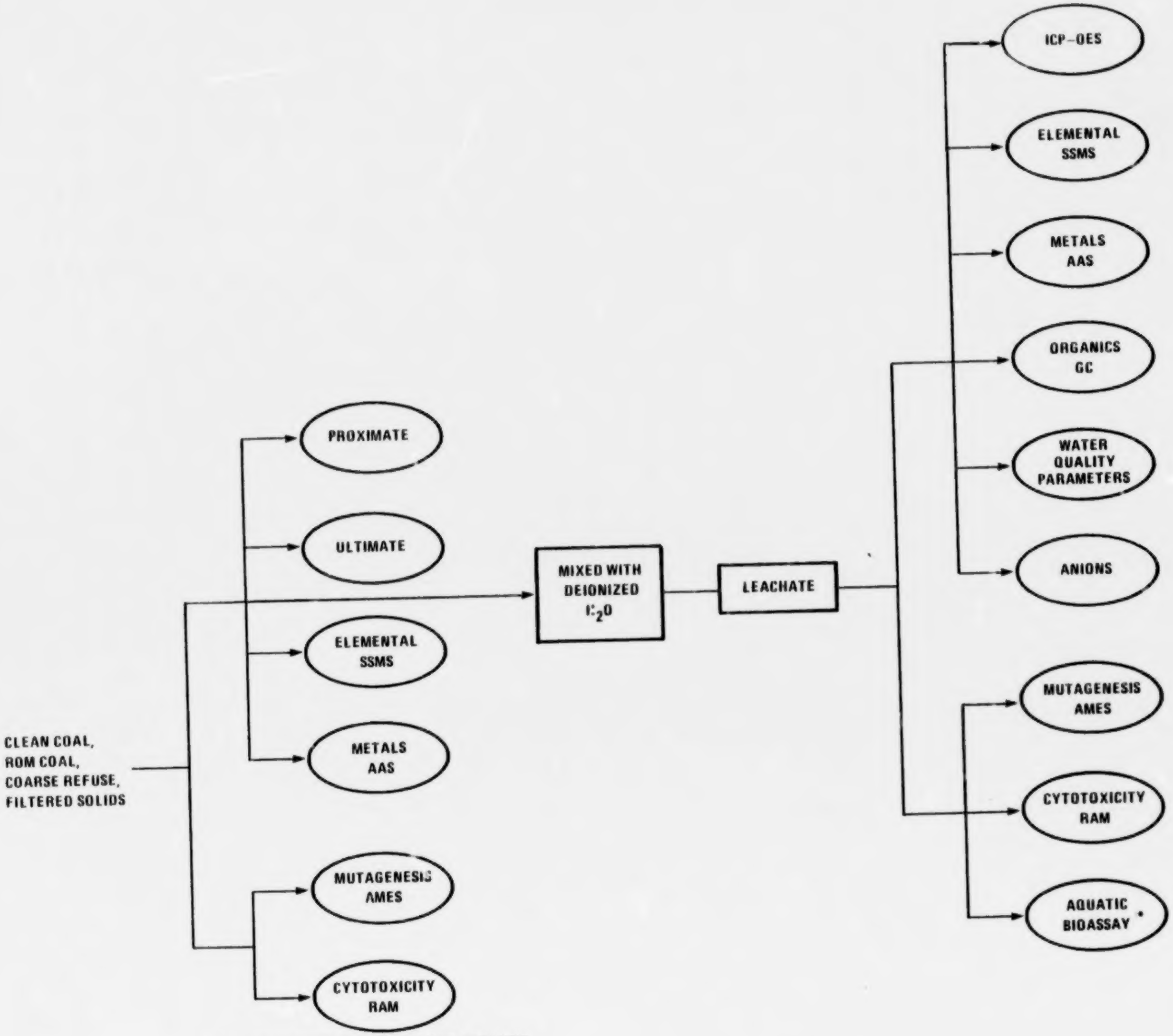
FIGURE 4-2 ANALYTICAL FLOW SCHEME FOR FUGITIVE VAPORS


ICP–OES
ELEMENTAL SSMS
METALS AAS
WATER QUALITY PARAMETERS
ANIONS
ORGANICS GC
POND WATER, FEEDWATER, SLURRY, FILTRATES, RUNOFF
MUTAGENESIS AMES +
CYTOTOXICITY CHO +
AQUATIC BIOASSAY* +

+UNFILTERED SLURRY USED IN BIOASSAYS

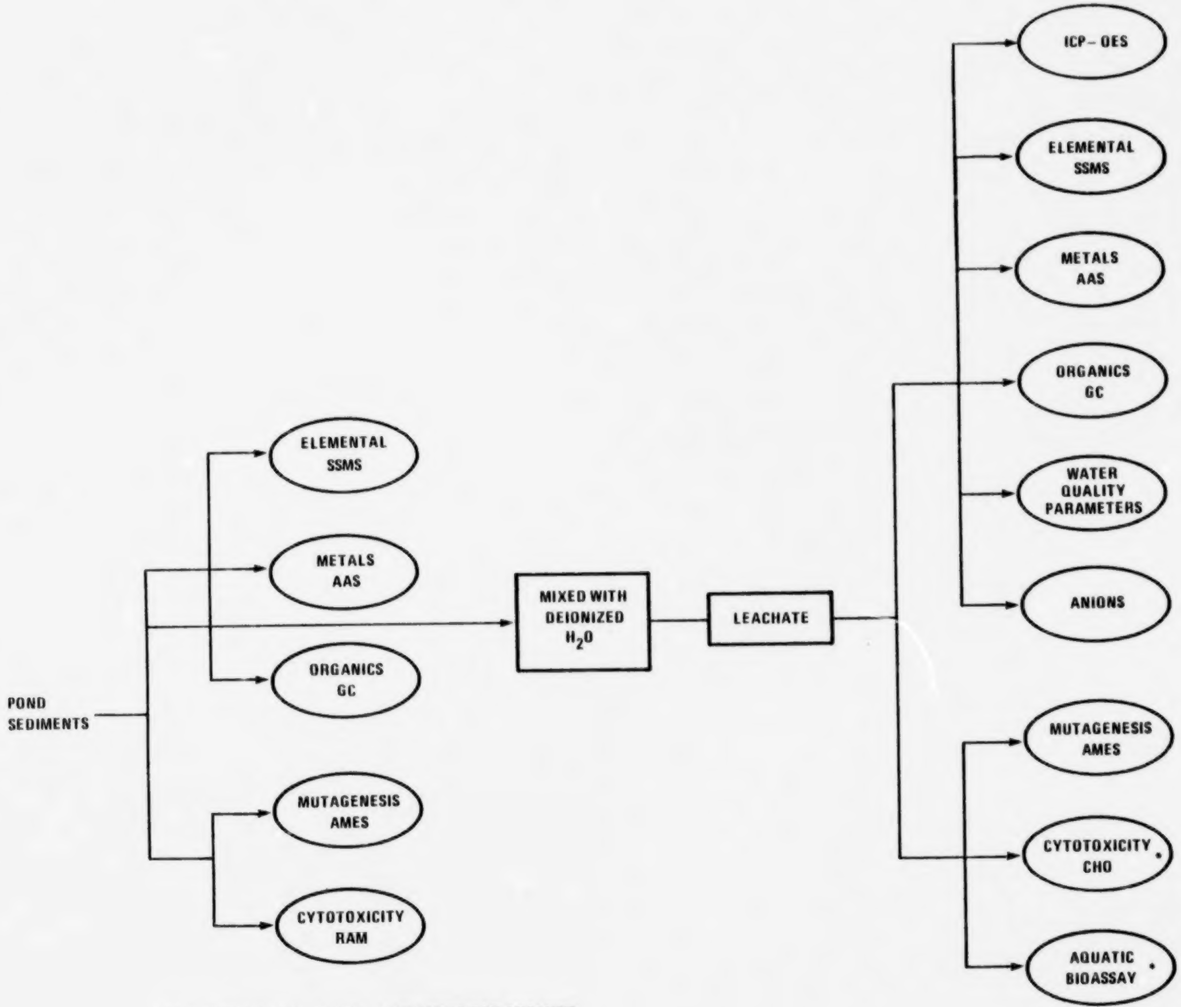
* AQUATIC BIOASSAY TESTS PERFORMED ON POND WATER AND SLURRY ONLY

FIGURE 4-3 ANALYTICAL FLOW SCHEME FOR POND WATER, FEEDWATER, SLURRY, FILTRATES, AND RUNOFF


CLEAN COAL,
ROM COAL,
COARSE REFUSE,
FILTERED SOLIDS
PROXIMATE
ULTIMATE
ELEMENTAL SSMS
METALS AAS
MUTAGENESIS AMES
CYTOTOXICITY RAM
MIXED WITH DEIONIZED H2O
LEACHATE
ICP–OES
ELEMENTAL SSMS
METALS AAS
ORGANICS GC
WATER QUALITY PARAMETERS
ANIONS
MUTAGENESIS AMES
CYTOTOXICITY RAM
AQUATIC BIOASSAY *

* LEACHATES WERE COMPOSITED FOR ANALYSIS

FIGURE 4-4 ANALYTICAL FLOW SCHEME FOR CLEAN COAL, ROM COAL, COARSE REFUSE, AND FILTERED SOLIDS


POND SEDIMENTS
ELEMENTAL SSMS
METALS AAS
ORGANICS GC
MUTAGENESIS AMES
CYTOTOXICITY RAM
MIXED WITH DEIONIZED H_2O
LEACHATE
ICP – OES
ELEMENTAL SSMS
METALS AAS
ORGANICS GC
WATER QUALITY PARAMETERS
ANIONS
MUTAGENESIS AMES
CYTOTOXICITY CHO *
AQUATIC BIOASSAY *

* SEDIMENT LEACHATES WERE COMPOSITED FOR ANALYSIS

FIGURE 4-5 ANALYTICAL FLOW SCHEME FOR POND SEDIMENTS

4.1.1 Water Quality Analyses

4.1.1.1 Chemical Oxygen Demand --

Chemical Oxygen Demand (COD) was determined by Standard Method No. 508.(2) The COD determination provides a measure of the amount of organic matter in a waste-water sample that is oxidizable by a strong chemical oxidant. The procedure consists of refluxing the sample with a mixture of potassium dichromate and sulfuric acid utilizing silver sulfate as a catalyst. The excess dichromate is then titrated with a standard ferrous ammonium sulfate solution. The amount of oxidizable organic matter in the waste sample is then proportional to the amount of potassium dichromate consumed by the chemical oxidants as determined by the titration. Inadequacies of the method are that straight chain aliphatic compounds, aromatic hydrocarbons, and pyridine are not oxidized by the chemical process.

4.1.1.2 Biochemical Oxygen Demand --

The Biochemical Oxygen Demand (BOD_5) was determined by Standard Method No. 507.(3) The BOD_5 determination measures the Dissolved Oxygen (DO) in the sample that is consumed by microbial life while assimilating and oxidizing the present organic matter. The procedure consists of measuring the initial DO content of the sample, sealing it in a glass stoppered bottle without air bubbles or headspace, and incubating the prepared samples for five days at 20°C in the dark. After five days of incubation, the DO is again measured and the BOD_5 determined from the reduction in dissolved oxygen. Dissolved oxygen was determined with a calibrated Yellow Spring Instrument Model 54A dissolved oxygen meter and probe.

4.1.1.3 pH--

Sample pH was determined using a Beckman Model SS-3 pH meter according to the EPA Method No. 150.1 (electrometric).(4) The pH meter was calibrated by commercial standard buffer solution. Sample mixing was accomplished with a magnetic stirrer.

4.1.1.4 Conductivity--

Conductivity was measured using a Yellow Spring Instrument Salinity, Conductivity, Temperature Meter, Model 33, which is equipped with a Wheatstone Bridge-type probe, according to the EPA Method No. 120.1.(5)

4.1.1.5 Hardness--

Hardness was determined by the Standard Method No. 309B, EDTA titrimetric method.(6) Hardness, determined by this method, represents the total concentration of calcium and magnesium ions expressed as calcium carbonate. The pH of the sample is adjusted to 10.0 ± 0.1 with a buffer solution. Eriochrome Black T was then added as an indicator changing the solution color to wine red. The sample was then titrated with standard ethylenediamine tetraacetic acid (EDTA) which complexes the magnesium and calcium ions. The endpoint is reached when the solution turns from wine red to blue.

4.1.1.6 Alkalinity--

Alkalinity was determined titrimetrically using EPA Method No. 310.1.(7) An aliquot of the sample was potentiometrically titrated to a pH of 4.5 with a standard acid (sulfuric or hydrochloric). The alkalinity, if measured as calcium carbonate, is an indicator of the concentration of carbonate, bicarbonate, and hydroxide present in the sample.

4.1.1.7 Acidity--

Acidity was determined titrimetrically by EPA Method No. 305.1.(8) The pH of the sample was determined and standard sulfuric acid was added to the sample to a pH of 4. Hydrogen peroxide was added, and the sample was boiled. The cooled sample was then titrated electrometrically to a pH of 8.2. The acidity is reported as calcium carbonate and is a measure of the mineral acidity of the sample, plus the acidity resulting from oxidation and hydrolysis of polyvalent cations, including salts of iron and aluminum.

4.1.1.8 Ammonia--

Ammonia was determined by EPA Method No. 350.1, the colorimetric automated phenate method.(9) A Technicon Autoanalyzer (AAII) was used for this procedure. The sample was run through the autoanalyzer's manifold where EDTA, an alkaline phenol solution of sodium phenolate, and a sodium hypochlorite solution were added to the sample to form indophenol blue. The blue color was intensified by addition of sodium nitroprusside, and the absorbence of the solution was measured at 660 nanometers through a 50-mm tubular flow cell. A strip chart recorder monitored the response (absorbance) of samples and standards run through the system. By comparing peak heights of standards to samples the ammonia concentration of each sample was calculated.

4.1.1.9 Nitrogen, Nitrate-Nitrite--

Nitrogen as nitrate and nitrite were measured using EPA Method No. 353.2, a colorimetric, automated cadmium reduction method.(10) This method was performed using a Technicon Autoanalyzer (AAII). By this method, nitrite is measured singly by diazotizing the sample with sulfanilamide and coupling with N-(1-naphthyl) - ethylenediamine hydrochloride solution to form a highly colored azo-dye. The absorbence is measured through a 15-mm cell at 520 nanometers. Nitrate is determined by passing the sample through a granulated copper-cadmium reduction column to reduce nitrate to nitrite and determining the nitrite originally present plus the reduced nitrate. Sample concentrations of nitrite and nitrate were determined by comparing their recorder response in peak height with those of standards.

4.1.1.10 Total Phosphorus and Ortho-Phosphate--

Phosphates were determined by EPA Method No. 365.2, a colorimetric, ascorbic acid method.(11) This method determines ortho-phosphate. Total phosphorus is thus determined by first converting the polyphosphates (and same organic phosphorus compounds) to ortho-phosphate by sulfur acid/ammonium persulfate hydrolysis and then determining the ortho-phosphate. Ammonium molybdate and antimony potassium tartrate are added to the sample in an acid medium of sulfuric acid and ascorbic acid. They react to form phosphomolybdic acid. This complex is reduced by the ascorbic acid to an intensely blue color. The absorbence of the blue complex is measured at 650 nanometers through a 50-mm cell using a Bausch & Lomb Spectronic 70 spectrophotometer. The concentration of samples was determined by comparing their absorbence to the absorbence of standards.

4.1.1.11 Sulfide--

Sulfide was determined by EPA Method No. 376.1, the titrimetric iodine method.(12) By this method a known excess of standard iodine is added to a sample that has been preserved with zinc acetate to produce zinc sulfide to sulfur under the acidic conditions. The samples were then back titrated with a reducing solution of standard sodium thiosulfate using a starch indicator to a clear endpoint. The concentration of sulfide is then determined from the amount of iodine consumed by the sulfide present in the sample.

4.1.1.12 Sulfate—

Sulfate was determined using EPA Method No. 375.2.(13) The Technicon Autoanalyzer (AAII) was used for this test. The sample is pumped through a cation-exchange column to remove multivalent metal ions. The sample is then reacted with an alcohol solution of barium chloride and methyl thymol blue (MTB) at a pH of 2.5-3.0 to form barium sulfate. The combined solution is raised to a pH of 12.5-13.0 so that excess barium reacts with MTB. The uncomplexed MTB color is gray; if it is diluted with barium, the color is blue. The amount of uncomplexed MTB is determined through a 15-mm cell at 460 nm. The amount of sulfate present is equal to the amount of uncomplexed MTB. The concentration of sulfate in each sample is calculated by comparison of the recorded response (in peak height) to the peak height of standards.

4.1.1.13 Fluoride (Electrode Method)—

Fluoride was analyzed by Standard Method No. 414B using an Orion Specific Ion Meter Model 701.(14) The fluoride ion-selective electrode is used to measure the concentration of fluoride in aqueous samples by use of a calibration curve of the potential established across a laser-type doped single lanthanium fluoride crystal by the presence of fluoride ion in an internal reference solution. The sample is first treated with a total ion strength adjustment buffer that overcomes variations in sample ionic strength and also contains a chelating agent to preferentially complex aluminum. Standards and samples are allowed to equilibrate to room temperature. The probe is immersed in the standards and samples and the potential measured while stirring the solution for three minutes.

4.1.1.14 Chloride—

Chloride was determined by EPA Method No. 325.3, the mercuric nitrate titrimetric method.(15) An acidified sample is titrated with standardized mercuric nitrate in the presence of mixed diphenylcarbazone - bromophenol blue indicator. The endpoint of the titration is the formation of the blue-violet mercury diphenylcarbazone.

4.1.1.15 Percent Solids—

Percent solids were determined on bulk solids and coal samples according to Standard Method No. 208G.(16) By this method the solids content was determined by drying a 50-100 g aliquot of sample at 104°C. The samples were weighed in dried, tared porcelain weighing dishes. After drying, the samples were cooled to room temperature in a desiccator and reweighed.

4.1.1.16 Leachate--

Leachates were prepared from pond sediment and coal samples for subsequent inorganic and organics analysis by the ASTM Proposed Method for Leaching of Waste Materials.(17) For coal samples a 1-kg aliquot was weighed and combined with a liter of deionized water in a 5-gal glass jug with a teflon-sealed lid. A 2-kg aliquot was used for pond sediments, and 8 ℓ of deionized water were added to the samples. The samples were agitated on a roller mill for 48 hours, allowed to settle, and then coarse-filtered through 7 μ glass fiber filters on a Buchner filtration unit. The filtrates were filtered twice through 0.45 μ membrane filters, and then split into appropriate sample containers for subsequent analysis. The samples were preserved and stored at 4°C until analyzed.

4.1.2 Elemental Analysis (Spark Source Mass Spectrometer)

Spark source mass spectrometry is one of the most sensitive multi-element techniques available for trace element analysis at the present time. Very low detection limits for all elements as well as total element coverage in a minimum time makes the technique a viable one for survey work.

The spark source mass spectrometer, installed and operating at the Instrumental Analysis Division of CTE, is an Associated Electrical Industries Model MS7 which is a Mattauch-type double focusing mass spectrometer specifically designed for the analysis of inorganic materials.

The design of the MS7 is based on the use of a spark ionization source which ensures that all elements are ionized with approximately equal sensitivity. This instrument utilizes a photographic plate as a detector. The photographic plate is a simple total integrator for the ion beam and a convenient permanent record of the mass spectra produced by the instrument. The photographic plate allows the highest resolving power of the instrument to be utilized providing maximum molecular and elemental species discrimination.

On a routine basis, the spark source mass spectrometer will give a trace element examination of all elemental constituents from lithium (mass 7) to uranium (mass 238) in as little as one hour. Values obtained from the analysis are considered accurate to within a factor of three

4.1.2.1 Calibration--

The spark source mass spectrometer is not in itself calibrated. Each sample analyzed has an internal standard of indium added at a know concentration during sample preparation. Elements detected are analyzed quantitatively by comparison with indium. Photoplates do give a different response to high m/e ions as compared to lower m/e ions. This difference in response is normally taken into account by the use of relative sensitivity factors for element determinations. Relative sensitivity factors were established in a carbon matrix by the use of NBS coal, fly ash, bovine liver, orchard leaves standards, USGS water, and geological standards.

4.1.2.2 Spark Source Mass Spectrometer Analysis Quality Control--

Quality control is maintained by periodically running NBS and other reference standards so that sets of reference spectra can be obtained for evaluation against routine samples. The number of reference standard analyses are determined by the sample load within the laboratory. Routinely, one or two standards are run every month and also when photographic plates from a new production lot are used.

4.1.2.3 Sample Analysis--

In the analysis of coals and refuse, the procedure includes the systematic division and reduction of the sample to minus 200 mesh. A portion of the coal is then mixed with an equal weight of high purity compactable graphite. An internal element standard, normally indium, is added along with a few drops of distilled ethyl alcohol. The mixture is slurried with distilled alcohol in an agate mortar and pestle. The sample-graphite slurry is evaporated to dryness. The procedure is then repeated until a homogeneous electrode mixture is assured. The sample-graphite mix is then formed into electrodes which are mounted in the source for sparking.

The mass spectrum is produced on a photoplate as a series of distinct lines, one for each element, and is a summation of the elemental components of the electrode. The ion intensity of each spectral line is related directly to the concentration of the components, at least over a concentration range of 10^5:1. Therefore, by running a series of decreasing exposures, the relative concentration of major to trace elements can be established by knowing the concentration of the internal standard added during sample preparation.

Particulate samples, which were collected on ultra high purity glass fiber filters with the high volume samplers, must be separated from the filter substrate before analysis. A portion of the filter is cut and placed in a glass centrifuge tube. The filter is then covered with spectrographic grade ethyl alcohol. The centrifuge tube and alcohol are subjected to ultrasonic shaking which removes the particulates from the surface and interior of the filter. The main portion of the cleaned filter is then removed and rinsed with alcohol, and the tube is centrifuged for a few minutes. The solids are quantitatively transferred to a mortar with the graphite, and an electrode is formed.

Liquid samples are prepared by evaporating successive aliquots with a heat lamp, mixing the residue with graphite, and forming an electrode.

4.1.2.4 Inductively Coupled Argon Plasma Optical Emission Spectroscopy--

A number of quality assurance samples prepared by the prime contractor were included with the initial samples submitted to the subcontractor for SSMS analysis. These control samples included method standards, blanks, and duplicate samples. The analyses of these control samples were then reviewed to evaluate the accuracy and precision of the SSMS data. Review of these data indicated the potential for serious problems in both the precision and accuracy of the SSMS data. To study these problems in more detail, all of the liquid samples obtained from the preparation plant, as well as leachates derived from solid samples, were analyzed by Inductively Coupled Argon Plasma Optical Emission Spectroscopy (ICP-OES) in the prime contractor's laboratory.

Liquid samples (water samples and solid leachates) were analyzed by ICP-OES after preliminary acid digestion. The concentrations for 27 elements listed below were measured utilizing a Jarrell-Ash Model 1140 ICP-OES system.

Aluminum
Antimony
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Gallium
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Silver
Sodium
Strontium
Tin
Titanium
Vanadium
Yttrium
Zinc

The digestion procedure utilized was designed to allow the determination of "total" metals content of the sample. These procedures are described in the Federal Register Volume 44, No. 233, December 3, 1979.

Results of these analyses have been included in this report in Appendix B along with comparable SSMS data. A qualitative review of these data points to a lack of precision and accuracy in the SSMS data. Spark source/mass spectroscopy analysis typically aims for precision, expressed as a coefficient of variation, of about 10 percent for each quantitative operation.

A quantitative evaluation of these results on an element-by-element basis was not possible because of a lack of sufficient data. To provide such an evaluation, the environmental assessment program will continue to duplicate the SSMS analyses with ICP-OES analyses while increasing the number of quality assurance samples to provide a larger data base on which to make a quantitative comparison. When calculating the discharge severity and total discharge severity values, the ICP-OES analytical concentrations were used for those twenty-seven elements listed above.

4.1.2.5 Mercury Determinations--

All solid samples (fugitive dusts, sediments, slurries, and coal samples) were prepared for analysis utilizing the 6 hour aqua-regia digestion procedure described in Appendix D of IERL-RTP Procedures Manual: Level 1 Environmental Assessment (second edition).(18) Solid sample digestates and water samples were then analyzed for mercury utilizing the cold vapor atomic absorption method, number 245.1 described in "Methods for Chemical Analysis of Water and Wastes," March 1979, EMSL U.S. EPA, Cincinnati, Ohio.(19)

4.1.3 Organics Analysis

4.1.3.1 Pond Water Extractions--

Aliquots of the pond water samples were filtered and extracted in-situ as discussed in Section 3.3.2. The extracts were transported to the laboratory in amber glass bottles with teflon seals and were stored at 4°C until analyzed. Prior to analysis, the sample extracts were dried and filtered through a column of sodium sulfate and concentrated to 10 mℓ by evaporation with Kuderna-Danish apparatus on a steam bath at 65-70°C.

4.1.3.2 Pond Sediment Extractions--

One hundred gram aliquots of the pond sediments were weighed into glass thimbles with coarse frits and secured with a glass wool plug. They were then soxhlet extracted with methylene chloride for 24 hours. The extract was dried and filtered through a column of sodium sulfate and concentrated to 10 mℓ by Kuderna-Danish evaporation on a steam bath at 65-70°C.

4.1.3.3 Pond Sediment Leachate and Coal Leachate Extractions--

A one liter aliquot of each leachate was extracted with methylene chloride at two pH levels, pH 2.0 and pH 12.0, using a 2 liter separatory funnel with Teflon stopcocks. Three extractions were performed at each pH level, using a total of 450 ml of methylene chloride. The individual extracts were combined, filtered and dried through a sodium sulfate column. The acid and base extracts were then concentrated to 10 mℓ by evaporation using a Kuderna-Danish apparatus on a steam bath at 65-70°C.

4.1.3.4 XAD-2 Resin Extractions--

A representative aliquot of the XAD-2 resin was weighed into glass thimbles with coarse frits, secured with glass wool plugs, and soxhlet extracted with methylene chloride for 24 hours. The extracts were dried and filtered through a column of sodium sulfate and concentrated to 10 mℓ by Kuderna-Danish evaporation on a steam bath at 65-70°C.

4.1.3.5 Total Chromatographable Organics Analysis--

The Total Chromatographable Organics (TCO) analysis was performed on concentrates after preliminary review showed very low levels by direct injection. The analysis was performed on a Hewlett-Packard 5710 gas chromatograph (GC) equipped with Flame Ionization Detector (FID) interfaced with a HP 3380 A integrator. Five microliter injections of each 10 mℓ extract were chromatographed under the following GC conditions:

Column: 6' x 2mm I.D. Glass, packed with 10 percent OV-101 on
100/120 Mesh Supelcoport (Supelco)

Carrier Gas: Helium, Matheson Purity (99.9999)

Carrier Gas Flow: 40 ml/min

Run Time: 30 minutes

Oven Temperature Program:

TEMPI	30°C for 4 minutes
RAMP	16°C/minute
FINAL TEMP	250°C

Detector Temperature: 300°C
Injection Port Temp: 250°C
Attenuation: 32

The FID detector and GC conditions were optimized daily to a 5 microliter injection of standard n-heptane solution. A five point calibration curve was constructed from a standard mixture of individual straight chain alkanes, n-hexane through n-heptadecane. The peak maxima of n-heptane and n-heptadecane were used to determine the retention time window for the analysis of the TCO materials within the 100°-300° boiling point range. For standards, the integrated areas of the peaks for n-octane through n-hexadecane were summed and plotted versus concentration. The areas of all peaks eluting within the C_7-C_{17} retention time window were calculated for the samples, a reagent blank value was subtracted, and concentrations were determined using the C_8-C_{16} calibration curve slope and y-intercept.

All chromatograms, extracts and analysts work notes are kept on file for at least one year after completion of the Level 1 assessment to provide any and all re-analysis that might be required to provide the most accurate analyses.

4.1.3.6 Gravimetric Analysis--

Gravimetric analysis of the 10 mℓ organic extracts was performed by pipetting 1 mℓ of the extract into a 2 mℓ tared glass weighing vial. The vials were placed in a desiccator and dried to a constant weight over drierite and reweighed. The difference in weight provided the gravimetric value.

4.1.3.7 Infrared Analysis--

Analysis by IR spectroscopy was not employed in this Level 1 assessment.

4.1.3.8 Liquid Chromatography - Low Resulution Mass Spectra Analysis--

The Liquid Chromatographic (LC) separation and L Resolution Mass Spectra Analysis (LRMS) are required when extracts are found to have a TCO + Grav of ≥ 15 mg. Since no extracts fall into this classification, these analysis were not required.

4.2 BIOASSAY ANALYSIS

The objective of the tests for health and ecological effects is to allow a biological evaluation of materials associated with the waste streams from a coal preparation plant. The materials evaluated include coal, refuse, sediments, feedwater, pond waters, particulates, fugitive organics, runoff, and leachates. Thirty-five samples of these materials were evaluated by one or more of the following tests: Salmonella/Microsome Mutagenesis (Ames) Assay, Rabbit Alveolar Macrophage (RAM) Assay, Chinese Hamster Ovary (CHO) Clonal Assay, Rodent Acute In-Vivo Test, and aquatic bioassays with a fish (fathead minnow, Pimephales promelas), an invertebrate (water flea, Daphnia magna), and an alga (Selenastrum capricornutum).

4.2.1 The Ames Test

The Samonella/Microsome Mutagenicity (Ames) Assays were conducted with four auxotrophic strains of Salmonella typhimurium according to procedures in Section 3.3.1 of IERL's procedural manual (U.S. EPA, 1977),$^{(21)}$ using specifications described in Ames et al., (1975).$^{(22)}$ Liquid samples were tested as received and filter papers were extracted with 40.0 mℓ sterile distilled water. Solids were pulverized with a mortar and pestle, filtered (0.45 μ), and oven dried.

The Ames test will be used as a primary screen to determine the mutagenic potential of complex mixtures or component fractions. The Ames assay is based on the property of selected Salmonella typhimurium mutants to revert from a histidine-requiring state to prototrophy due to exposure to various classes of mutagens. The test can detect nanogram quantities of mutagens.

Prior to mutagenicity testing, toxicity of each sample was determined with two bacterial tester strains. Excess histidine was added to the top agar and low initial cell counts (10^3 cells/ml) were employed to allow the auxotrophic bacteria to proliferate and grow. If sample plate counts were much lower than the control plate counts, then the sample was considered toxic at that concentration. If toxicity occurred, concentrations employed in the mutagenicity assay would be one-half of the lowest toxic concentration observed during this phase of testing.

Toxicity testing was performed with tester strains TA 98 and TA 100, which were each cultivated in 45 mℓ nutrient broth, and diluted to a cell concentration of 10^2-10^3 cells/mℓ in 0.85 percent saline solution. Media were prepared by addition of 10 mℓ excess histidine-biotin to 100 mℓ tempered top agar and dispensed into sterile test tubes (13 x 100 mm) in 2-mℓ aliquots. Three concentrations of each field sample were tested with 0.1 mℓ of each tester strain. This top agar solution was gently shaken and evenly spread on the surface of Vogel-Bonner minimal salt medium plates. Each test was performed in duplicate. Plates were incubated for 48 hours at 37°C and examined to determine if cell death had occurred. The concentrations of samples employed in the mutagenicity assay were less than one-half of the least toxic level.

Mutagenicity testing was performed with tester strains TA 98, TA 100, TA 1535, and TA 1537, each of which was cultivated in 45 mℓ nutrient broth. Media were prepared by addition of 10 mℓ trace histidine-biotin to 100 mℓ tempered top agar and dispersed into sterile test tubes (13 x 100 mm) in 2-mℓ aliquots. Four concentrations (0.05-1.0 mℓ sample/tube) of each field sample were tested with 0.1 mℓ of each tester strain. This top agar solution was gently shaken and evenly spread on the surface of Vogel-Bonner minimal salt medium plates. Each test was performed in duplicate. Plates were incubated for 48 hours at 37°C and examined to determine if cell reversion rates had increased. If a compound caused a reversion rate twice the spontaneous reversion rate, the substance was considered positively mutagenic. If a sample exhibited a positive result in the initial mutagenicity test, it was re-evaluated using a narrower range of concentrations. These results were then used to compute a dose-response curve.

Due to the nature of certain samples, a spot test was employed initially to determine toxicity and mutagenicity. The procedures for both tests were unchanged, except that top agar was layered onto the Vogel-Bonner plates before the sample was introduced. The sample was placed on the surface of the plate and incubated at 37°C for 48 hours. A clear zone around the spot extending out into the medium was an indication of toxicity. A zone of increased reversion around a spot sample, particularly if excessive, was an indication of mutagenesis.

4.2.2 Chinese Hamster Ovary Clonal Assay

Chinese Hamster Ovary (CHO) Clonal Assays were conducted according to Section 3.3.2.3 of IERL's procedural manual (U.S. EPA, 1977),(23) with detailed procedures drawn from Winniger et al., (1978).(24)

Cultures of Chinese hamster ovary cells (ATCC-CCL61) at 80 percent confluency in 25 cm^2 tissue culture flasks were prepared for testing by harvesting (i.e., 2-5 minute treatment at 37°C with 0.25 percent trypsin in calcium- and magnesium- free phosphate buffered saline). After detachment of cells from the flask, an equal volume of complete culture medium (nutrient medium F10 supplemented with 10 percent fetal calf serum, penicillin [100 units/mℓ], and streptomycin [100 μg/mℓ]) was added. The suspended cells were centrifuged (200 X g) at room temperature for 10 minutes, the supernatant was discarded, the cells were resuspended in 10 mℓ complete culture medium , and then counted with a haemocytometer or automatic cell counter. Cells were diluted in complete culture medium to a concentration of 1,000 cells/10 mℓ. Cell suspensions were prepared in 500-mℓ sterile glass bottles filled to 50 percent capacity. Ten mℓ aliquots of the cell suspension were dispensed into 15 x 100 mm tissue culture Petri dishes and incubated in a moist atmosphere (95 percent air/5 percent CO_2) at 37°C for 18 to 24 hours. After this time, the culture medium was removed by aspiration and replaced with 10 mℓ of complete media containing the various concentrations of test materials, negative (culture medium) or positive (cadmium chloride, 0.05-0.20 g/mℓ) controls. Cultures were incubated in a moist atmosphere at 37°C for 5-6 days, after which time the culture medium was removed and the cells fixed with 5 mℓ fixative (10 percent formaldehyde, 0.5 percent sodium chloride, and 4 percent methanol in deionized water) for 5 minutes at room temperature. After removal of fixative, cells were stained with 5 mℓ, 0.04 percent crystal violet for 5 minutes at room temperature, washed three times with deionized water, and air-dried. The number of colonies produced was counted using an automatic colony counter.

The percent colony survival was determined according to the formula:

$$\frac{\text{Colonies in test sample}}{\text{Colonies in medium control}} \times 100 = \%\ \text{colony survival.}$$

The EC_{50} (effective concentration producing 50 percent colony survival) was calculated from the log concentration versus % response graph.

4.2.3 Rodent Acute In-Vivo Test

Rodent acute in-vivo tests were performed according to Section 3.3.3 of IERL's procedures manual (U.S. EPA, 1977).(25) Five male and five female Sprague-Dawley rats (approximately 250 g) were quarantined under close scrutiny for a minimum of 7 days to assure healthy test groups.

Animals were fed a nutritionally balanced standard commercial laboratory feed which supports normal growth and maintenance. Food and water were supplied ad libitum.

On day 0 of the study, rats were administered an acute dose of undiluted test material equal to 10 g/kg body weight by intra-gastric gavage. After treatment the rats were held 14 days for observation. Clinical signs of toxicity were recorded daily beginning on day 0. Observations included bizarre physical positions, bizarre tail positions, righting reflexes, lethargy, spontaneous convulsions, tremors, behavioral changes, sleep, coma, salivation, and lacrimation. Also noted were any signs of dyspnea, cyanosis, nasal discharge, abnormal excreta, skin abnormalities, pilo erection, changes in food consumption and body weight, and mortality. Frequency and severity of all observed abnormalities was scored, and onset and disappearance of clinical signs was noted. Animals that became moribund or judged unable to live 24 hours were killed and necropsied. At termination of the study all surviving animals were killed and necropsied. If no mortality occurred in the quantal study, no further investigations were performed, and the LC_{50} (lethal dose for 50 percent of the animals) was reported as greater than 10 g/kg.

4.2.4 Rabbit Alveolar Macrophage Assay

Rabbit Alveolar Macrophage (RAM) Assays were conducted according to Section 3.3.2.1 of IERL's procedural manual (U.S. EPA, 1977),(26) with detailed procedures drawn from Waters (1975), and Gardner et al., (1973).(27)

Alveolar macrophage cells were obtained from the lungs of male or female white New Zealand rabbits (1.2-2.5 kg) by tracheobronchial lavage. Tracheobronchial lavage consisted of the injection of 30-mℓ sterile 0.85 percent sodium chloride (warmed to 37°C) into the lungs, and the collection of the fluid (now containing cells) after 15 minutes. Fluid was dispensed into 50-mℓ centrifuge tubes and the procedure repeated an additional five times (after the first injection, the 15-minute contact period was omitted). If lavage fluid was contaminated with erythrocytes, it was discarded.

Samples were prepared for testing by several techniques. Liquid samples were tested as received. Solids were pulverized in a wedgewood motar and pestle, and added to sterile deionized water in 100-mℓ glass bottles at the rate of 40 mg sample per 10 mℓ water. Filter papers were placed in 20 x 100 mm petri dishes containing deionized water at the rate of 300 mg filter paper per 10 mℓ water. After a 15-minute contact time, the water was repipetted over the filter paper ten times, and the particulate suspension transferred to a sterile 100-mℓ glass bottle.

One mℓ aliquots of cell suspension were dispensed into each well of a 3.5 x 1.0 cm Linbro six-well plate. One mℓ of each concentration of sample was added to each well and agitated. Each concentration was tested in duplicate wells. Plates were incubated in a moist atmosphere (95 percent air/5 percent CO_2)at 37°C on a rocker platform set at twenty excursions per minute. Following a 20-hour incubation period, plates were iced, and the contents of each well were repipetted four times and dispensed into 12 x 75 mm test tubes (iced).

The number of cells was measured directly with a haemacytometer. The percent viability was determined by centrifuging (8,000 X g) a 200 µℓ aliquot of cell suspension at room temperature for 5 minutes, discarding the supernatant, treating the centrifuged cells with 100 µℓ of 0.04 percent Trypan blue, and vortexing. After a 10-minute exposure at room temperature, the cells were examined microscopically for dye exclusion.

The percent phagocytosis was determined by centrifuging 1.8 mℓ of cell suspension (5,000 X g) at 4°C for 10 minutes, discarding the supernatant, and resuspending the centrifuged cells in complete culture medium containing 1.09 µ- diameter latex beads at the rate of 20 beads per cell. Cell suspensions were incubated in a moist atmosphere (95 percent air/ 5 percent CO_2) on a rocker platform (twenty excursions per minute). After 60 minutes of incubation, smears were prepared on microscope slides. Extracellular latex beads were dissolved by treating the slides for 3 hours with xylene. One hundred cells were then examined microscopically, and the percent of cells which had ingested one or more beads was determined.

Cytotoxicity determinations were based on the median effective concentration (EC_{50}) values calculated from the ATP content of each well and the percent phagocytosis. These two parameters were selected to assess cytotoxicity because these were the most sensitive indicators of toxicity. EC_{50} values were derived by graphical interpolation between data points bracketing the 50 percent effect concentration.

4.2.5 Aquatic Bioassays with Fish and Invertebrates

Aquatic bioassays with fish were conducted with fathead minnows (Pimephales promelas) according to procedures in Section 3.4.2 of IERL's procedural manual (U.S. EPA, 1977).(28) Tests were conducted at 22±1°C (established in a walk-in environmental chamber) with dechlorinated tap water used as diluent and control water. This water exhibited the following physical/chemical characteristics: hardness - 42 mg/ℓ; alkalinity - 33 mg/ℓ; TOC - 5 mg/ℓ; suspended solids - <5 mg/ℓ; conductivity - 250 μmhos/cm, and has been shown repeatedly to allow survival of first instar Daphnia magna for 48 hours without food. Fish employed in the tests were obtained from a commercial supplier and held at 20-22°C in diluent water under recirculating conditions for a minimum of 4 days prior to testing. Mortality of fish during the 48 hours prior to testing was less than 5 percent.

Fish were exposed to six concentrations of sample (0 percent, 100 percent, 60 percent, 40 percent, 25 percent, and 15 percent), with one replicate per concentration. Each replicate consisted of 10 fish in a 19 ℓ all-glass aquarium containing 10 ℓ of test solution. Fish were randomly placed in the six aquaria within 1 hour after test solutions had been added, and aquaria were randomly positioned in the environmental chamber. A photoperiod of 16 hours of light and 8 hours of dark was provided during testing. The test was conducted for 96 hours, during which the fish were not fed. Survival and sublethal responses of fish were recorded at 0, 2, 4, 8, 12, 24, 48, 72, and 96 hours after exposure to samples. Dead fish were removed from aquaria at these times. Temperature of the environmental chamber was continuously recorded (Model RFT Recording Thermometer). Dissolved oxygen concentration (YSI Model 57 Meter) was measured in each aquarium at initiation of testing and thereafter at 24-hour intervals. Conductivity (USI Model 33 Meter) and pH (Orion Research Model 701 Meter) were recorded in each aquarium at initiation of testing.

Median lethal concentrations (LC_{50}) for animals exposed to test samples were calculated for 24, 48, and 96 hours of exposure. The moving average method was employed and the LC_{50} generated with the largest data span.

Aquatic bioassays with the invertebrate Daphnia magna were conducted according to procedures in Section 3.4.2 of IERL's procedural manual (U.S. EPA, 1977).(29) Tests were conducted at 17±1°C (established in an incubator) with the same dechlorinated tapwater used as diluent and control water.

Daphnia magna used in the tests were obtained from laboratory cultures maintained according to procedures in Standard Methods for the Examination of Water and Wastewater (APHA, 1975).(30) Cultures were maintained in dechlorinated tapwater at 17±1°C. First instar juveniles were used for all tests. Daphnia magna were exposed to six concentrations of sample (0 percent, 100 percent, 60 percent, 40 percent, 25 percent, and 15 percent) with four replicates per concentration. Each replicate consisted of five Daphnia magna in a 250 mℓ glass beaker containing 100 mℓ of test solution.

Animals were randomly placed in the test vessels within 1 hour after test solutions had been added, and test vessels were randomly positioned in the incubator. A photoperiod of 16 hours of light and 8 hours of dark was provided during the tests. The test was conducted for 48 hours during which the animals were not fed. Survival and sublethal responses (immobilization) were recorded at 0, 2, 4, 8, 12, 24, and 48 hours after exposure to samples. Immobilized animals were removed from the test vessels at those times. Temperature of the incubator was continuously monitored. Dissolved oxygen was measured in one replicate test vessel of each concentration at initiation of the test.

Median effective concentrations (EC_{50}) based on immobilization for animals exposed to test samples were calculated for 24 and 48 hours of exposure by Stephan's (1978) computer program.(31) The moving average method was employed and the EC_{50} generated with the largest data span was selected.

4.2.6 Aquatic Bioassay with Algae

The alga *Selenastrum capricornutum*, was tested according to methods described in Section 3.4.1 of IERL's procedural manual (U.S. EPA, 1977).(32) All samples were filtered (0.45 membrane filter) prior to use. The cultures of *Selenastrum capricornutum* were transferred to sterile Bristol's solution which is prepared by addition of the following compounds to 1 ℓ of distilled water:

$NaNO_3$	25.0 mg
$CaCl_2$	2.50 mg
$MgSO_4 \cdot 7H_2O$	7.50 mg
K_2HPO_4	7.50 mg
KH_2PO_4	17.50 mg
$NaCl_2$	2.50 mg
$FeCl_3$	0.50 mg

Cultures were transferred to sterile Bristol's solution in 250-mℓ Erlenmeyer flasks containing 60 mℓ of media, a minimum of three times prior to testing. Cultures were maintained at 24±2°C under continuous lighting at 400 foot-candles delivered by fluorescent lights. Test inoculum was prepared by centrifuging (1,000 X g) cells from a 7-day old culture, resuspending the cells in a 15,000 μg/ℓ $NaHCO_3$ solution, recentrifuging, and resuspending the cells in the $NaHCO_3$ solution to yield a concentration of 60,000 cells/mℓ. Four test concentrations (0 percent sample, 100 percent, 50 percent, and 10 percent) were established, with three replicates employed per concentration, and Bristol's solution used for dilution and control purposes. In preparing each replicate of a test solution, 1 mℓ of test inoculum was combined with 59 mℓ of test medium in a 250-mℓ Erlenmeyer flask, and resulted in an initial concentration of 1,000 algal cells per mℓ of solution.

The test was conducted for 21 days under the experimental conditions described for the preparatory incubation period except that test flasks were randomly positioned on a rotary shaker platform. On days 1, 2, 3, 4, 5, 6, 7, 9, 12, 17, and 21 the number of cells per mℓ in each replicate of each test solution (concentration) was determined by haemocytometer measurement; for days 12, 17, and 21, the average number of cells in each noncontrol solution was divided by the average number of cells in the control solution. These quotients were multiplied by 100 (percent of control) and the median effective concentration (EC_{50}) for the diatom was derived by graphical interpolation on semilogarithmic paper between data points bracketing the EC_{50}. The specific growth rate was determined for the control and each noncontrol solution for days 1, 2, 3, 4, 5, 7, 9, 12, 17, and 21 according to the following formula:

$$\begin{matrix}\text{specific}\\ \text{growth}\\ \text{rate}\end{matrix} = \frac{\begin{matrix}\text{ln (cell concentration at end of interval/cell concen-}\\ \text{tration at beginning of interval)}\end{matrix}}{\text{length of interval (days)}} \quad .$$

SECTION 5.0

TEST RESULTS

The test results of the Source Test and Evaluation program for coal preparation plant No. 1 are presented in this section. Section 5.1 provides the methodology for evaluating test results, and Section 5.2 contains the chemical and biological test results for each waste stream and an evaluation of the data.

5.1 METHODS OF CHARACTERIZING WASTE STREAMS

Three methods were used to evaluate the characteristics of the waste streams from the coal preparation plant:

- Source Analysis Model 1A (SAM/1A) evaluation.
- Water quality parameter comparisons with existing standards.
- Bioassay screening tests.

5.1.1 SAM/1A Evaluation

The Energy Assessment and Control Division of the EPA's Industrial Environmental Research Laboratory at Research Triangle Park (EACD/IERL-RTP) has developed a standardized methodology for interpreting the results obtained from environmental assessment test programs. This methodology uses Source Analysis Models (SAM's) which represent prototype approaches to multimedia, multipollutant problem identification and control effectiveness evaluation for complex effluents.

The simplest member of the Source Analysis Models, SAM/1A, was used for this STE program. SAM/1A provides a rapid screening technique for evaluating the pollution potential of gaseous, liquid, and solid waste streams. In performing a SAM/1A evaluation, an index, the Discharge Severity (DS), is determined for each substance in a discharge.

The DS is calculated by dividing the detected concentration of a compound, or class of compounds, by its Discharge Multimedia Environmental Goal (DMEG) value (for both health and ecological effects) as reported in the Multimedia Environmental Goals for Environmental Assessment Volume II.(33) The DMEG's are concentration levels of contaminants in air, water, or solid waste effluents that will not evoke significant harmful responses if exposed to humans or to the ecosystem.

For example, the estimated concentration of aluminum in the fine waste slurry filtrate sample was analyzed to be 190 μg/ℓ. The health-based DMEG value for aluminum in a liquid discharge is 8.0×10^4 as stated in Volume II of Multimedia Environmental Goals for Environmental Assessment.

$$\mathrm{DS} = \frac{190\ \mu g/\ell}{8.0 \times 10^4\ \mu g/\ell} = 2.4 \times 10^{-3}$$

As shown above, the discharge severity for aluminum is calculated to be 2.4×10^{-3} or 2.4 E-3. A DS value greater than one indicates a potential hazard, while a value less than one indicates little or no potential hazard. A Total Stream Discharge Severity (TDS) is calculated by summing the DS's for all constituents found in a sample.

$$\text{Total Discharge Severity (TDS)} = \Sigma \mathrm{DS}$$

There are several assumptions and limitations implicit in the use of the SAM/1A evaluation technique. These include:

- Transport of the components in the waste streams to the external environment occurs without chemical or physical transformation of those components.
- Actual dispersion of a pollutant from a source to a receptor will be equal to, or greater than, the safety factors normally applied to acute toxicity data to convert these data to estimated safe chronic exposure levels.

- Extrapolation of acute toxicity data for animals (i.e., LD_{50}) to no effects levels in man entails many assumptions which are not properly validated.
- No consideration has been given to additive effects from simultaneous exposure through different media.
- The MEGs methodology does not consider synergisms or antagonisms with regard to health or ecology. Severity is considered as simply additive.
- The biological fate, i.e., metabolism and site of action of chemicals, is not considered. Metabolic alterations into more or less active metabolites, i.e., intoxication and detoxication, are not considered.
- Persistence in the environment with regard to bioaccumulation or degradation is not specifically considered in the current MEGs.
- Use of Threshold Limit Values (TLVs®): ACGIH has made it clear that the TLVs® are to be used only in the practice of industrial hygiene and that it does not recommend their use as a relative index of hazard or toxicity.
- The level of confidence to be associated with MEGs values derived from the models is not known. Information reported in the NIOSH Registry of Toxic Effects of Chemical Substances has been used extensively in calculating MEG values. NIOSH, in compiling the Registry, has made no attempt to report the numbers of animals tested, quantity or site of tumors produced in carcinogenicity studies, or precise conditions under which the data were obtained. The level of confidence to be associated with toxicity data such as LD_{50}, LD_{10}, TD_{10}, LC_{50}, or LC_{10} is very dependent upon this information.
- LD_{50} values may vary widely for a given compound in relation to species, sex, and age of the animals tested, the route of administration of the toxicant, and other test conditions. Because they are available for most compounds, oral LD_{50} values have been

employed rather than LD_{50} values derived from other routes of administration. While this procedure allows for consistency in the calculations and LD_{50} values are the basis of some models based on correlations of LD_{50}s with TLVs®, obvious complications in the use of LD_{50} values arise, e.g., differences in the oral absorption factors among the various chemical substances.

These assumptions, along with the accuracy of the test data and assumptions used in developing DMEG values, must be considered when interpreting test results using the SAM/1A methodology. It should be noted that, based on updated information from Research Triangle Institute, the ecological DMEG values for solids should be two orders of magnitude higher than the values reported in the November 1977 Multimedia Environmental Goals for Environmental Assessment Volume II publication. The higher values were used in the SAM/1A evaluation.

Results of the inorganic analyses were evaluated using SAM/1A. The inorganic data were obtained from trace element, water quality, and gaseous species analyses. When calculating the discharge severity and total discharge severity values, the inductively coupled argon plasma (ICP) analytical concentrations were used for the twenty-seven elements listed in Section 4.1.2.4.

The total concentration of organic extractables in each sample was obtained from Grav and TCO determinations. These results were not evaluated using the SAM/1A methodology because the MEG values are specific to individual organic compounds which are not identified by Grav and TCO analysis.

5.1.2 Biological Test Analysis

The testing of industrial feed and waste streams for biological effects is needed to complement the physical and chemical data and to ensure that the assessment is comprehensive. Biological testing can provide an indication of toxicity and mutagenicity of substances to organisms that the other tests cannot. This is especially important when dealing with substances for which there is little available data on toxicity or when assessing complex mixtures where synergisms and antagonisms may alter the toxicity of the individual components. The use of biological assays in conjunction with other tests provides a better data base from which to prioritize streams relative to further study and/or control technology needs.

Biological test result evaluations are based on a subjective interpretation of the data in terms of low, moderate, or high effects for each test. Note that these interpretations are based on the biological responses of highly sensitive cellular as well as whole-organism cultures. The positive response of these indicator-type organisms or cells can be considered to be a worst case situation. Low or non-detectable effects indicate that the material will not have any adverse health or ecological effects. Moderate or high effects indicate that the material may be potentially hazardous and more rigorous testing should be initiated before an ultimate fate can be established.

5.2 TEST RESULTS SUMMARY AND ANALYSIS

5.2.1 Chemical and Biological Test Results

The chemical and biological test results from the Source Test and Evaluation program at coal preparation plant No. 1 are presented for the following:

- Fugitive air emissions.
- Liquid waste streams.
- Solid waste streams.
- Organics.
- Additional chemical test results.

5.2.2 Fugitive Air Emissions

Fugitive Total Suspended Particulates (TSP) and vapors were sampled downwind from the ROM coal pile, the clean coal pile, and the coarse refuse pile. Samples were also taken downwind and upwind of the coal preparation facility. Fugitive particulates were sampled using Hi-Vols to obtain ambient concentrations and with cascade impactors to determine particle size distribution. The particulates were analyzed for chemical content using SSMS and were studied for particulate morphology. The vapors captured by the XAD-2 resin were also analyzed using SSMS. Both the particulates and vapors were analyzed for total organic content. Additionally, biological assessments were performed on both the particulate matter (i.e., Ames assay and RAM) and the fugitive vapors (i.e., Ames assay).

Table 5-1 presents the ambient TSP and TCO + Grav concentrations measured from the Hi-Vols and XAD-2 resins respectively. Note that all samples were taken within the plant boundaries. The values tend to be highest around the coal piles, as expected, because of the continual coal handling activity in those areas. For comparison purposes, the 24-hour primary and secondary ambient air quality standards for TSP are 260 and 150 $\mu g/m^3$, respectively.

The TCO + Grav results may be compared with the three-hour total hydrocarbon ambient air quality standard of 160 $\mu g/m^3$. However, if one assumes that the upwind value of 170 $\mu g/m^3$ represents background concentrations, then the preparation plant is contributing little or no gaseous organic matter to the environment. Also, the higher ROM coal pile value of 240 $\mu g/m^3$ may be attributed to the continuous diesel truck activity around the Kentucky No. 9 coal pile and nearby coarse refuse storage bin. Further detailed organics analysis would be required to determine the amount of organic gaseous matter attributable to diesel truck activity.

The total discharge severity values for all five fugitive emission sources are quite similar and are summarized in Table 5-2. Biological tests for fugitive emissions are summarized in Table 5-3 through 5-5. The health and ecological TDS values for all five fugitive particulate samples are less than or equal to 1×10^{-2}.

Tables 5-6 through 5-8 summarize the SAM/1A evaluation results and bioassay results for the vapors. There were a few individual elements with a DS greater than one when compared to the health DMEG. As a result, the TDS for health ranged from 8 to 64. For ecological DMEGs, only downwind vapors produced a TDS greater than one (i.e., TDS = 2). These low TDS values are also reflected in the biological assessment results which showed little or no effects.

Tables 5-9 through 5-18 present the test results and discharge severity values for the individual inorganic elements in each of the particulate and vapor samples taken at the five locations.

TABLE 5-1. SUMMARY OF TOTAL SUSPENDED PARTICULATE AND TCO + GRAV (VAPOR) MEASUREMENTS

Sample Source	Distance From Source	No. of Hrs. Measured	Average Daily Windspeed	TSP Concentration	TCO + Grav Concentration
Clean Coal Pile	200 m	13	12 Knots	512 $\mu g/m^3$	140 $\mu g/m^3$
Coarse Refuse Pile	300 m	10	<4 Knots	354 $\mu g/m^3$	50 $\mu g/m^3$
ROM Coal Pile	300 m	13	12 Knots	1,163 $\mu g/m^3$	240 $\mu g/m^3$
Upwind (Ambient)	600 m from preparation plant	18	<4 Knots	222 $\mu g/m^3$	170 $\mu g/m^3$
Downwind	500 m from preparation plant	18	<4 Knots	397 $\mu g/m^3$	50 $\mu g/m^3$

TABLE 5-2. SUMMARY OF TOTAL DISCHARGE SEVERITY VALUES FOR FUGITIVE PARTICULATE AND VAPOR DISCHARGES

Fugitive Discharge Source	Health TDS	Ecological TDS	Compounds Found From Chemical Analysis	
			Health	Ecological
Particulates				
Clean Coal Pile	5E-3	9E-3	-	-
Coarse Refuse Pile	3E-3	1E-3	-	-
ROM Coal Pile	1E-2	1E-2	-	-
Upwind (Ambient)	4E-3	3E-3	-	-
Downwind (Prep. Plant)	3E-3	2E-3	-	-
Vapors				
Clean Coal Pile	3E0	2E-1	Cr	-
Coarse Refuse Pile	1E1	3E-1	Cr, Th	-
ROM Coal Pile	4E0	2E-1	Cr,	-
Upwind (Ambient)	3E0	3E-1	Cr,	-
Downwind (Prep. Plant)	6E1	2E0	Cr,	V

TABLE 5-3. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR CLEAN COAL, COARSE REFUSE, AND ROM STORAGE PILE FUGITIVE PARTICULATES

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
10^3 - 10^4				
10^2 - 10^3	No discharge severity	values greater than 1.	HEALTH	
			Ames	Negative
			*RAM (EC_{50})	145 µℓ/mℓ (% phagocytosis);nontoxic
				≈354 µℓ/mℓ (nmol ATP/well);nontoxic
10 - 10^2				
			ECOLOGICAL	
1 - 10				
			Tests not conducted.	

*Composite of ROM, Clean Coal, and coarse refuse fugitive particulates.

TABLE 5-4. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR UPWIND FUGITIVE PARTICULATES

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$				
$10^2 - 10^3$			HEALTH	
	No discharge severity	values greater than 1.	Ames	Negative
			RAM (EC_{50})	224 μℓ/mℓ (% phagocytosis);nontoxic >300 μℓ/mℓ (nmol ATP/well);nontoxic
$10 - 10^2$				
			ECOLOGICAL	
$1 - 10$			Tests not conducted.	

TABLE 5-5. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR DOWNWIND FUGITIVE PARTICULATES

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$				
$10^2 - 10^3$			HEALTH	
	No discharge severity	values greater than 1.	Ames	Negative
			RAM (EC_{50})	89 μℓ/mℓ (% phagocytosis);
				nontoxic (nmol ATP/well)
$10 - 10^2$				
			ECOLOGICAL	
$1 - 10$				
			Tests not conducted.	

TABLE 5-6. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR VAPORS FROM CLEAN COAL AND ROM STORAGE PILES, AND FOR UPWIND VAPORS

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$				
$10^2 - 10^3$			HEALTH Ames	 Negative
$10 - 10^2$		No Discharge Severity Values Greater Than 1.		
$1 - 10$	Cr		ECOLOGICAL Tests not conducted.	

TABLE 5-7. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR VAPORS FROM COARSE REFUSE PILE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$		No Discharge Severity Values Greater Than 1.	HEALTH Ames Negative ECOLOGICAL Tests not conducted.
$10^2 - 10^3$			
$10 - 10^2$			
1 - 10	Cr, Th		

TABLE 5-8. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR DOWNWIND VAPORS

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
10^3 - 10^4				
10^2 - 10^3			HEALTH	
			Ames	Negative
10 - 10^2	Cr			
			ECOLOGICAL	
1 - 10		V	Tests not conducted.	

TABLE 5-9. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR CLEAN COAL FUGITIVE PARTICULATES

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>0.08	>2E-5	N	a		39. Gallium	0.002	5E-7	N	g	
47. Ammonia						44. Germanium	<.000009	<2E-8	N	a	
50. Antimony	<.000009	<2E-8	N	a		80. Gold	<.000009	N	N		
49. Arsenic	0.002	9E-4	N	c		64. Hafnium	<.000009	N	N		
36. Barium	0.02	4E-5	N	a		Holmium	<.000009	N	N		
32. Beryllium	0.00005	2E-5	N	a		59. Iodine	0.0004	N	N		
51. Bismuth	<.000009	<2E-8	N	a		Iridium	<.000009	N	N		
37. Boron	0.03	9E-6	N	a		72. Iron	>0.4	N	N		
58. Bromine	0.0084	N	N			84. Lanthanum	0.001	N	N		
82. Cadmium	≤0.0002	≤2E-5	N	a		46. Lead	0.008	6E-5	N	a	
34. Calcium	*	N	N			27. Lithium	0.001	5E-5	N	a	
84. Cerium	0.0009	N	N			Lutecium	<.000009	N	N		
31. Cesium	0.0001	N	N			33. Magnesium	>0.3	>5E-5	N	a	
57. Chlorine	0.2	N	N			71. Manganese	0.09	2E-5	N	c	
68. Chromium	0.002	2E-3	N	c		83. Mercury	0.0005	1E-5	5E-5	c	c
74. Cobalt	<0.0009	<2E-5	N	a		69. Molybdenum	<0.0009	<2E-7	N	a	
78. Copper	<0.004	<2E-5	N	a		84. Neodymium	0.0005	N	N		
84. Dysprosium	<.000009	N	N			76. Nickel	0.003	2E-4	N	f	
Erbium	<.000009	N	N			66. Niobium	0.002	N	N		
Europium	<.000009	N	N			Osmium	<.000009	N	N		
56. Fluorine	≈0.01	N	N			Palladium	<.000009	N	N		
Gadolinium	<.000009	N	N			48. Phosphorus	0.1	1E-3	N	a	

* Major Component of the Blank.

TABLE 5-9. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR CLEAN COAL FUGITIVE PARTICULATES

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	<.000009	N	N			67. Tantalum	<.000009	N	N		
29. Potassium	> 0.3	>1E-4	N	a		55. Tellurium	<.000009	<9E-8	N	a	
84. Praseodymium	0.0003	N	N			Terbium	<.000009	N	N		
Rhenium	<.000009	N	N			41. Thallium	<.000009	<9E-8	N	a	
75. Rhodium	<.000009	N	N			85. Thorium	<0.0009	<1E-4	N	h	
30. Rubidium	0.002	N	N			Thulium	<.000009	N	N		
73. Ruthenium	<.0000009	N	N			45. Tin	≤0.0001	N	N		
84. Samarium	<.0000009	N	N			62. Titanium	>0.5	>8E-5	N	a	
60. Scandium	<0.0005	<9E-9	N	g		70. Tungsten	<.000009	<9E-9	N	a	
54. Selenium	≤0.002	≤1E-5	N	a		85. Uranium	<0.0009	<1E-4	N	h	
43. Silicon	>0.09	N	N			65. Vanadium	0.009	2E-5	9E-3	a	a
79. Silver	<.000009	<9E-7	N	a		Ytterbium	.000005	N	N		
28. Sodium	>0.2	N	N			61. Yttrium	0.001	N	N		
35. Strontium	0.04	1E-5	N	g		81. Zinc	0.02	6E-6	N	a	
53. Sulfur	>0.4	N	N			63. Zirconium	0.01	N	N		

Total Discharge Severity = 5E-3 9E-3

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-10. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE FUGITIVE PARTICULATES

MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	0.04	8E-6	N	a		39. Gallium	<0.0002	<5E-8	N	g	
47. Ammonia						44. Germanium	<0.0001	<2E-7	N	a	
50. Antimony	<0.0001	<2E-7	N	a		80. Gold	<0.0001	N	N		
49. Arsenic	≤0.0001	≤6E-5	N	c		64. Hafnium	<0.0001	N	N		
36. Barium	<0.04	<7E-5	N	a		Holmium	<0.0001	N	N		
32. Beryllium	<0.00006	<3E-5	N	a		59. Iodine	<0.0001	N	N		
51. Bismuth	<.0001	<3E-7	N	a		Iridium	<0.0001	N	N		
37. Boron	0.05	2E-5	N	a		72. Iron	0.06	N	N		
58. Bromine	0.003	N	N			84. Lanthanum	<0.003	N	N		
82. Cadmium	<0.0001	1E-5	N	a		46. Lead	0.002	2E-5	N	a	
34. Calcium	*	N	N			27. Lithium	0.0001	5E-6	N	a	
84. Cerium	<0.002	N	N			Lutecium	<0.0001	N	N		
31. Cesium	<0.0001	N	N			33. Magnesium	0.2	4E-5	N	a	
57. Chlorine	0.2	N	N			71. Manganese	0.0006	1E-7	N	c	
68. Chromium	0.002	2E-3	N	c		83. Mercury	0.0004	9E-6	4E-6	c	c
74. Cobalt	<0.0002	5E-6	N	a		69. Molybdenum	<0.001	<2E-7	N	a	
78. Copper	<0.005	<2E-5	N	a		84. Neodymium	<0.0001	N	N		
84. Dysprosium	<0.0001	N	N			76. Nickel	0.002	2E-4	N	f	
Erbium	<0.0001	N	N			66. Niobium	0.0002	N	N		
Europium	<0.0001	N	N			Osmium	<0.0001	N	N		
56. Fluorine	<0.2	N	N			Palladium	<0.0001	N	N		
Gadolinium	<0.0001	N	N			48. Phosphorus	<0.01	<1E-4	N	a	

* Major Component of the Blank.

TABLE 5-10. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE FUGITIVE PARTICULATES

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	<0.0001	N	N			67. Tantalum	<0.0001	N	N		
29. Potassium	>0.4	>2E-4	N	a		55. Tellurium	<0.0001	<1E-6	N	a	
84. Praseodymium	0.00006	N	N			Terbium	<0.0001	N	N		
Rhenium	<0.0001	N	N			41. Thallium	<0.0001	<1E-6	N	a	
75. Rhodium	<0.0001	N	N			85. Thorium	<0.0006	<7E-5	N	h	
30. Rubidium	0.0002	N	N			Thulium	<0.0001	N	N		
73. Ruthenium	<0.0001	N	N			45. Tin	<0.0001	N	N		
84. Samarium	<0.0001	N	N			62. Titanium	0.006	1E-6	N	a	
60. Scandium	<0.0001	<2E-9	N	g		70. Tungsten	<0.0001	<1E-7	N	a	
54. Selenium	0.001	6E-6	N	a		85. Uranium	<0.001	<1E-4	N	h	
43. Silicon	>0.1	N	N			65. Vanadium	0.001	2E-6	1E-3	a	a
79. Silver	<0.0001	<1E-5	N	a		Ytterbium	<0.0001	N	N		
28. Sodium	>0.4	N	N			61. Yttrium	0.0002	N	N		
35. Strontium	0.002	8E-7	N	g		81. Zinc	0.006	2E-6	N	a	
53. Sulfur	0.1	N	N			63. Zirconium	0.0008	N	N		
						Total Discharge Severity =		3E-3	1E-3		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-11. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR ROM FUGITIVE PARTICULATES

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>0.03	>6E-6	N	a		39. Gallium	0.002	5E-7	N	g	
47. Ammonia						44. Germanium	≤0.0001	≤3E-7	N	a	
50. Antimony	0.0001	3E-7	N	a		80. Gold	<0.000005	N	N		
49. Arsenic	0.001	7E-4	N	c		64. Hafnium	<0.000005	N	N		
36. Barium	0.06	1E-4	N	a		Holmium	<0.000005	N	N		
32. Beryllium	<0.00005	<2E-5	N	a		59. Iodine	0.0003	N	N		
51. Bismuth	<0.000005	<1E-8	N	a		Iridium	<0.000005	N	N		
37. Boron	0.03	9E-6	N	a		72. Iron	>0.4	N	N		
58. Bromine	0.001	N	N			84. Lanthanum	0.0009	N	N		
82. Cadmium	0.0002	2E-5	N	a		46. Lead	0.004	3E-5	N	a	
34. Calcium	*	N	N			27. Lithium	0.002	9E-5	N	a	
84. Cerium	0.008	N	N			Lutecium	<0.000005	N	N		
31. Cesium	0.0005	N	N			33. Magnesium	>0.3	>5E-5	N	a	
57. Chlorine	0.09	N	N			71. Manganese	0.1	3E-5	N	c	
68. Chromium	0.009	9E-3	N	c		83. Mercury	0.0009	2E-5	9E-5	c	c
74. Cobalt	<0.005	<9E-5	N	a		69. Molybdenum	<0.001	<3E-7	N	a	
78. Copper	0.006	3E-5	N	a		84. Neodymium	0.0009	N	N		
84. Dysprosium	<0.000005	N	N			76. Nickel	0.002	2E-4	N	f	
Erbium	<0.000005	N	N			66. Niobium	0.001	N	N		
Europium	0.00009	N	N			Osmium	<0.000005	N	N		
56. Fluorine	≃0.03	N	N			Palladium	<0.000005	N	N		
Gadolinium	0.0002	N	N			48. Phosphorus	0.1	1E-3	N	a	

* Major Component of the Blank.

TABLE 5-11. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR ROM FUGITIVE PARTICULATES

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological
77. Platinum	<0.000005	N	N		
29. Potassium	> 0.3	>1E-4	N	a	
84. Praseodymium	0.0002	N	N		
Rhenium	<0.000005	N	N		
75. Rhodium	<0.000005	N	N		
30. Rubidium	0.005	N	N		
73. Ruthenium	<0.000005	N	N		
84. Samarium	0.0005	N	N		
60. Scandium	<0.0002	<3E-9	N	g	
54. Selenium	0.0009	5E-6	N	a	
43. Silicon	>0.09	N	N		
79. Silver	≤0.0001	≤1E-5	N	a	
28. Sodium	>0.2	N	N		
35. Strontium	0.05	2E-5	N	g	
53. Sulfur	>0.4	N	N		
67. Tantalum	<0.000005	N	N		
55. Tellurium	0.0001	1E-6	N	a	
Terbium	0.00009	N	N		
41. Thallium	<0.000005	<5E-8	N	a	
85. Thorium	<0.0009	<1E-4	N	h	
Thulium	<0.000005	N	N		
45. Tin	0.0003	N	N		
62. Titanium	0.2	3E-5	N	a	
70. Tungsten	<0.000005	<5E-9	N	a	
85. Uranium	<0.0009	<1E-4	N	h	
65. Vanadium	0.01	3E-5	1E-2	a	a
Ytterbium	<0.000005	N	N		
61. Yttrium	0.0009	N	N		
81. Zinc	0.01	3E-6	N	a	
63. Zirconium	0.004	N	N		
Total Discharge Severity =		1E-2	1E-2		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-12. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR UPWIND FUGITIVE PARTICULATES

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	<0.003	<6E-7	N	a		39. Gallium	0.0003	7E-8	N	g	
47. Ammonia	-					44. Germanium	0.00003	6E-8	N	a	
50. Antimony	0.0001	3E-7	N	a		80. Gold	<0.00003	N	N		
49. Arsenic	0.0006	3E-4	N	c		64. Hafnium	<0.00003	N	N		
36. Barium	<0.02	<4E-5	N	a		Holmium	<0.00003	N	N		
32. Beryllium	<0.00003	<2E-5	N	a		59. Iodine	0.0002	N	N		
51. Bismuth	<0.00003	<8E-8	N	a		Iridium	<0.00003	N	N		
37. Boron	<0.007	<2E-6	N	a		72. Iron	>0.3	N	N		
58. Bromine	0.002	N	N			84. Lanthanum	<0.002	N	N		
82. Cadmium	0.00003	3E-6	N	a		46. Lead	0.006	4E-5	N	a	
34. Calcium	*	N	N			27. Lithium	<0.0003	<1E-5	N	a	
84. Cerium	<0.001	N	N			Lutecium	<0.00003	N	N		
31. Cesium	0.0002	N	N			33. Magnesium	>0.2	>4E-5	N	a	
57. Chlorine	0.007	N	N			71. Manganese	0.07	1E-5	N	c	
68. Chromium	0.001	1E-3	N	c		83. Mercury	0.0005	1E-5	5E-5	c	c
74. Cobalt	<0.001	<2E-5	N	a		69. Molybdenum	<0.0003	<7E-8	N	a	
78. Copper	<0.003	<1E-5	N	a		84. Neodymium	0.0002	N	N		
84. Dysprosium	<0.00003	N	N			76. Nickel	0.0004	2E-5	N	f	
Erbium	<0.00003	N	N			66. Niobium	0.0003	N	N		
Europium	<0.00003	N	N			Osmium	<0.00003	N	N		
56. Fluorine	≈0.007	N	N			Palladium	<0.00003	N	N		
Gadolinium	<0.00003	N	N			48. Phosphorus	0.2	2E-3	N	a	

* Major Component of the Blank.

TABLE 5-12. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR UPWIND FUGITIVE PARTICULATES

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological
77. Platinum	<0.00003	N	N		
29. Potassium	>0.07	>3E-5	N	a	
84. Praseodymium	0.0001	N	N		
Rhenium	<0.00003	N	N		
75. Rhodium	<0.00003	N	N		
30. Rubidium	0.007	N	N		
73. Ruthenium	<0.00003	N	N		
84. Samarium	0.00007	N	N		
60. Scandium	<0.00007	<1E-9	N	g	
54. Selenium	<0.00003	<2E-7	N	a	
43. Silicon	>0.07	N	N		
79. Silver	<0.00003	<3E-6	N	a	
28. Sodium	>0.03	N	N		
35. Strontium	0.010	3E-6	N	g	
53. Sulfur	>0.08	N	N		
67. Tantalum	<0.00003	N	N		
55. Tellurium	<0.00003	<3E-7	N	a	
Terbium	<0.00003	N	N		
41. Thallium	<0.00003	<3E-7	N	a	
85. Thorium	<0.0007	<7E-5	N	h	
Thulium	<0.00003	N	N		
45. Tin	0.00007	N	N		
62. Titanium	>0.3	>5E-5	N	a	
70. Tungsten	<0.00003	<3E-8	N	a	
85. Uranium	<0.0007	<7E-5	N	h	
65. Vanadium	0.003	5E-6	3E-3	a	a
Ytterbium	<0.00003	N	N		
61. Yttrium	0.0002	N	N		
81. Zinc	0.007	2E-6	N	a	
63. Zirconium	0.0008	N	N		
Total Discharge Severity =		4E-3	3E-3		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenicity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-13. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR DOWNWIND FUGITIVE PARTICULATES

MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>0.01	>3E-6	N	a		39. Gallium	<0.00003	<7E-9	N	g	
47. Ammonia						44. Germanium	<0.00003	<6E-8	N	a	
50. Antimony	<0.00003	<7E-8	N	a		80. Gold	<0.00003	N	N		
49. Arsenic	0.0003	2E-4	N	c		64. Hafnium	<0.00003	N	N		
36. Barium	0.007	1E-5	N	a		Holmium	<0.00003	N	N		
32. Beryllium	<0.00003	<2E-5	N	a		59. Iodine	<0.00003	N	N		
51. Bismuth	<0.00003	<8E-8	N	a		Iridium	<0.00003	N	N		
37. Boron	0.02	6E-6	N	a		72. Iron	0.2	N	N		
58. Bromine	0.001	N	N			84. Lanthanum	<0.002	N	N		
82. Cadmium	<0.00003	<3E-6	N	a		46. Lead	0.01	6E-5	N	a	
34. Calcium	*	N	N			27. Lithium	0.00003	2E-6	N	a	
84. Cerium	<0.001	N	N			Lutecium	<0.00003	N	N		
31. Cesium	0.0001	N	N			33. Magnesium	>0.2	>4E-5	N	a	
57. Chlorine	0.007	N	N			71. Manganese	0.01	3E-6	N	c	
68. Chromium	0.002	2E-3	N	c		83. Mercury	0.0005	9E-5	5E-5	c	c
74. Cobalt	<0.0002	<3E-6	N	a		69. Molybdenum	<0.0003	<7E-8	N	a	
78. Copper	0.0007	3E-6	N	a		84. Neodymium	≤0.00003	N	N		
84. Dysprosium	<0.00003	N	N			76. Nickel	0.00003	2E-6	N	f	
Erbium	<0.00003	N	N			66. Niobium	<0.0003	N	N		
Europium	<0.00003	N	N			Osmium	<0.00003	N	N		
56. Fluorine	≈0.007	N	N			Palladium	<0.00003	N	N		
Gadolinium	<0.00003	N	N			48. Phosphorus	0.03	3E-4	N	a	

TABLE 5-13. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR DOWNWIND FUGITIVE PARTICULATES

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Discharge Severity (Estimated Conc/ DMEG Conc) Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
77. Platinum	<0.00003	N	N		
29. Potassium	>0.2	>9E-5	N	a	
84. Praseodymium	<0.0001	N	N		
Rhenium	<0.00003	N	N		
75. Rhodium	<0.00003	N	N		
30. Rubidium	0.002	N	N		
73. Ruthenium	<0.00003	N	N		
84. Samarium	<0.00003	N	N		
60. Scandium	<0.00003	<6E-10	N	g	
54. Selenium	≤0.00007	≤3E-7	N	a	
43. Silicon	>0.07	N	N		
79. Silver	<0.00003	<3E-6	N	a	
28. Sodium	>0.07	N	N		
35. Strontium	0.02	6E-6	N	g	
53. Sulfur	<0.1	N	N		
67. Tantalum	<0.00003	N	N		
55. Tellurium	<0.00003	<3E-7	N	a	
Terbium	<0.00003	N	N		
41. Thallium	<0.00003	3E-7	N	a	
85. Thorium	<0.0007	8E-5	N	h	
Thulium	<0.00003	N	N		
45. Tin	<0.00003	N	N		
62. Titanium	0.06	1E-5	N	a	
70. Tungsten	<0.00003	<3E-8	N	a	
85. Uranium	<0.0007	<8E-5	N	h	
65. Vanadium	0.002	3E-6	2E-3	a	a
Ytterbium	<0.00003	N	N		
61. Yttrium	0.0002	N	N		
81. Zinc	0.01	3E-6	N	a	
63. Zirconium	0.0004	N	N		
Total Discharge Severity =		3E-3	2E-3		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-14. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM CLEAN COAL

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	<29	5.5E-3	N	a		39. Gallium	<0.2	<4E-5	N	g	
47. Ammonia						44. Germanium	<0.2	<4E-4	N	a	
50. Antimony	<0.2	<4E-4	N	a		80. Gold	<0.2	N	N		
49. Arsenic	<0.2	<1E-1	N	c		64. Hafnium	<0.2	N	N		
36. Barium	<7	<1E-2	N	a		Holmium	<0.2	N	N		
32. Beryllium	<0.2	<1E-1	N	a		59. Iodine	<0.4	N	N		
51. Bismuth	<0.2	<5E-4	N	a		Iridium	<0.2	N	N		
37. Boron	2	6E-4	N	a		72. Iron	<64	N	N		
58. Bromine	<2	N	N			84. Lanthanum	1	N	N		
82. Cadmium	<0.9	<9E-2	N	a		46. Lead	<1	<7E-3	N	a	
34. Calcium	<594	N	N			27. Lithium	<0.9	<4E-2	N	a	
84. Cerium	<0.7	N	N			Lutecium	<0.2	N	N		
31. Cesium	<0.4	N	N			33. Magnesium	<97	<1.6E-2	N	a	
57. Chlorine	<59	N	N			71. Manganese	0.7	1E-4	N	c	
68. Chromium	<2	<2E0	N	c		83. Mercury	<0.09	<2E-3	<9E-3	c	c
74. Cobalt	0.2	4E-3	N	a		69. Molybdenum	<2	<4E-4	N	a	
78. Copper	<9	<4E-2	N	a		84. Neodymium	<0.2	N	N		
84. Dysprosium	<0.2	N	N			76. Nickel	*	*	N	f	
Erbium	<0.2	N	N			66. Niobium	<0.4	N	N		
Europium	<0.2	N	N			Osmium	<0.2	N	N		
56. Fluorine	<22	N	N			Palladium	<0.2	N	N		
Gadolinium	<0.2	N	N			48. Phosphorus	<20	2E-1	N	a	

* Possible contamination of the blank and therefore discharge severity not calculated.

TABLE 5-14. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM CLEAN COAL

(continued)

MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Discharge Severity (Estimated Conc/ DMEG Conc) Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
77. Platinum	<2	N	N		
29. Potassium	572	2.86E-1	N	a	
84. Praseodymium	0.2	N	N		
Rhenium	<0.2	N	N		
75. Rhodium	<0.2	N	N		
30. Rubidium	<0.2	N	N		
73. Ruthenium	<0.2	N	N		
84. Samarium	<0.2	N	N		
60. Scandium	<0.2	<4E-6	N	g	
54. Selenium	<0.2	<1E-3	N	a	
43. Silicon	<90	N	N		
79. Silver	<0.2	<2E-2	N	a	
28. Sodium	<44	N	N		
35. Strontium	<11	<4E-3	N	g	
53. Sulfur	51	N	N		
67. Tantalum	<0.2	N	N		
55. Tellurium	<0.2	<2E-3	N		
Terbium	<0.2	N	N		
41. Thallium	<0.2	<2E-3	N	a	
85. Thorium	<2	<2E-1	N	h	
Thulium	<0.2	N	N		
45. Tin	<0.2	N	N		
62. Titanium	<7	<1E-3	N	a	
70. Tungsten	<02	<2E-4	N	a	
85. Uranium	<2	<2E-1	N	h	
65. Vanadium	<0.2	<4E-4	<2E-1	a	a
Ytterbium	<0.2	N	N		
61. Yttrium	<0.2	N	N		
81. Zinc	<44	<1.1E-2	N	a	
63. Zirconium	<0.7	N	N		
Total Discharge Severity =		3E0	2E-1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-15. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM COARSE REFUSE PILE

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	12	2.3E-[illegible]	N	a		39. Gallium	<0.9	<2E-4	N	g	
47. Ammonia						44. Germanium	<0.9	<2E-3	N	a	
50. Antimony	<0.9	<2E-3	N	a		80. Gold	<0.9	N	N		
49. Arsenic	≤0.6	≤3E-1	N	c		64. Hafnium	<0.9	N	N		
36. Barium	12	2E-2	N	a		Holmium	<0.9	N	N		
32. Beryllium	<0.9	<4E-1	N	a		59. Iodine	≤0.6	N	N		
51. Bismuth	<0.9	<2E-3	N	a		Iridium	<0.9	N	N		
37. Boron	0.6	2E-4	N	a		72. Iron	23	N	N		
58. Bromine	18	N	N			84. Lanthanum	<0.9	N	N		
82. Cadmium	<0.9	<9E-2	N	a		46. Lead	<6	<4E-2	N	a	
34. Calcium	<791	N	N			27. Lithium	0.3	1E-2	N	a	
84. Cerium	<0.9	N	N			Lutecium	<0.9	N	N		
31. Cesium	<0.9	N	N			33. Magnesium	<129	<2.1E-2	N	a	
57. Chlorine	390	N	N			71. Manganese	4	8E-4	N	c	
68. Chromium	9	9E0	N	c		83. Mercury	0.1	3E-3	1E-2	c	c
74. Cobalt	≤0.9	≤2E-2	N	a		69. Molybdenum	6	1E-3	N	a	
78. Copper	23	1E-1	N	a		84. Neodymium	<0.9	N	N		
84. Dysprosium	<0.9	N	N			76. Nickel	*	*	N	f	
Erbium	<0.9	N	N			66. Niobium	<0.9	N	N		
Europium	<0.9	N	N			Osmium	<0.9	N	N		
56. Fluorine	<29	N	N			Palladium	<0.9	N	N		
Gadolinium	<0.9	N	N			48. Phosphorus	18	2E-1	N	a	

* Possible contamination of the blank and therefore discharge severity not calculated.

TABLE 5-15. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM COARSE REFUSE PILE

(continued)

MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration ($\mu g/m^3$)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	<0.9	N	N			67. Tantalum	<0.9	N	N		
29. Potassium	<850	<4.3E-1	N	a		55. Tellurium	<0.9	<9E-3	N	a	
84. Praseodymium	<0.9	N	N			Terbium	<0.9	N	N		
Rhenium	<0.9	N	N			41. Thallium	<0.9	<9E-3	N	a	
7[illegible]. Rhodium	<0.9	N	N			85. Thorium	<9	<1E0	N	h	
30. Rubidium	<0.6	N	N			Thulium	<0.9	N	N		
73. Ruthenium	<0.9	N	N			45. Tin	<0.9	N	N		
84. Samarium	<0.9	N	N			62. Titanium	18	3E-3	N	a	
60. Scandium	<0.6	<1E-5	N	g		70. Tungsten	<0.9	<9E-4	N	a	
54. Selenium	<0.9	<4E-3	N	a		85. Uranium	<6	<7E-1	N	h	
43. Silicon	35	N	N			65. Vanadium	<0.3	<6E-4	<3E-1	a	a
79. Silver	<0.9	<9E-2	N	a		Ytterbium	<0.9	N	N		
26. Sodium	557	N	N			61. Yttrium	0.9	N	N		
[illegible]5. Strontium	<15	<5E-3	N	g		81. Zinc	9	2E-3	N	a	
53. Sulfur	226	N	N			63. Zirconium	0.9	N	N		
						Total Discharge Severity =		1E1	3E-1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-16. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM ROM STORAGE PILE

MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	<30	<5.8E-3	N	a		39. Gallium	<0.2	<5E-5	N	g	
47. Ammonia						44. Germanium	<0.2	<4E-4	N	a	
50. Antimony	<0.2	<5E-4	N	a		80. Gold	<0.2	N	N		
49. Arsenic	≤0.9	≤5E-1	N	c		64. Hafnium	<0.2	N	N		
36. Barium	5	9E-3	N	a		Holmium	<0.2	N	N		
32. Beryllium	<0.2	<1E-1	N	a		59. Iodine	<0.5	N	N		
51. Bismuth	<0.2	<6E-4	N	a		Iridium	<0.2	N	N		
37. Boron	2	7E-4	N	a		72. Iron	<67	N	N		
58. Bromine	<2	N	N			84. Lanthanum	<0.2	N	N		
82. Cadmium	<0.2	<2E-2	N	a		46. Lead	<1	<8E-3	N	a	
34. Calcium	<624	N	N			27. Lithium	<0.9	<4E-2	N	a	
84. Cerium	<0.2	N	N			Lutecium	<0.2	N	N		
31. Cesium	<0.2	N	N			33. Magnesium	<102	<1.7E-2	N	a	
57. Chlorine	<62	N	N			71. Manganese	<1	<3E-4	N	c	
68. Chromium	<2	<2E0	N	c		83. Mercury	<0.09	<2E-3	<9E-3	c	c
74. Cobalt	2	3E-2	N	a		69. Molybdenum	<2	<5E-4	N	a	
78. Copper	25	1.3E-1	N	a		84. Neodymium	<0.2	N	N		
84. Dysprosium	<0.2	N	N			76. Nickel	*	*	N	f	
Erbium	<0.2	N	N			66. Niobium	<0.2	N	N		
Europium	<0.2	N	N			Osmium	<0.2	N	N		
56. Fluorine	<23	N	N			Palladium	<0.2	N	N		
Gadolinium	<0.2	N	N			48. Phosphorus	<21	<2.1E-1	N	a	

* Possible contamination of the blank and therefore discharge severity not calculated.

TABLE 5-16. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR VAPORS FROM ROM STORAGE PILE

(continued)

MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/m³)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	<2	N	N			67. Tantalum	<0.2	N	N		
29. Potassium	<670	<3.4E-1	N	a		55. Tellurium	<0.2	<2E-3	N	a	
84. Praseodymium	<0.2	N	N			Terbium	<0.2	N	N		
Rhenium	<0.2	N	N			41. Thallium	<0.2	<2E-3	N	a	
75. Rhodium	<0.2	N	N			85. Thorium	<2	<3E-1	N	h	
30. Rubidium	<0.5	N	N			Thulium	<0.2	N	N		
73. Ruthenium	<0.2	N	N			45. Tin	<0.2	N	N		
84. Samarium	<0.2	N	N			62. Titanium	<7	<1E-3	N	a	
60. Scandium	<0.2	<4E-6	N	g		70. Tungsten	<0.2	<2E-4	N	a	
54. Selenium	<0.2	<1E-3	N	a		85. Uranium	<2	<2E-1	N	h	
43. Silicon	<95	N	N			65. Vanadium	<0.2	<5E-4	<2E-1	a	a
79. Silver	<0.2	<2E-2	N	a		Ytterbium	<0.2	N	N		
28. Sodium	<231	N	N			61. Yttrium	<0.2	N	N		
35. Strontium	<12	<4E-3	N	g		81. Zinc	<46	1.2E-2	N	a	
53. Sulfur	60	N	N			63. Zirconium	≤4	N	N		
						Total Discharge Severity =		4E0	2E-1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-17. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR UPWIND VAPORS

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	24	4.7E-3	N	a		39. Gallium	<0.3	<7E-5	N	g	
47. Ammonia						44. Germanium	<0.3	<6E-4	N	a	
50. Antimony	<0.3	<7E-4	N	a		80. Gold	<0.3	N	N		
49. Arsenic	<0.2	<8E-2	N	c		64. Hafnium	<0.3	N	N		
36. Barium	<4	<8E-3	N	a		Holmium	<0.3	N	N		
32. Beryllium	<0.3	<2E-1	N	a		59. Iodine	1	N	N		
51. Bismuth	<0.3	<8E-4	N	a		Iridium	<0.3	N	N		
37. Boron	0.2	5E-5	N	a		72. Iron	<49	N	N		
58. Bromine	8	N	N			84. Lanthanum	<0.3	N	N		
82. Cadmium	<0.3	<3E-2	N	a		46. Lead	<2	<1E-2	N	a	
34. Calcium	<441	N	N			27. Lithium	<0.8	<3E-2	N	a	
84. Cerium	<0.3	N	N			Lutecium	<0.3	N	N		
31. Cesium	<0.3	N	N			33. Magnesium	<72	<1.2E-2	N	a	
57. Chlorine	167	N	N			71. Manganese	<1	<2E-4	N	c	
68. Chromium	<2	<2E0	N	c		83. Mercury	<0.07	<1E-3	<7E-3	c	c
74. Cobalt	1	2E-2	N	a		69. Molybdenum	3	7E-4	N	a	
78. Copper	8	4E-2	N	a		84. Neodymium	<0.3	N	N		
84. Dysprosium	<0.3	N	N			76. Nickel	*	*	N	f	
Erbium	<0.3	N	N			66. Niobium	<0.3	N	N		
Europium	<0.3	N	N			Osmium	<0.3	N	N		
56. Fluorine	<15	N	N			Palladium	<0.3	N	N		
Gadolinium	<0.3	N	N			48. Phosphorus	2	2E-2	N	a	

* Possible contamination of the blank and therefore discharge severity not calculated.

TABLE 5-17. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR UPWIND VAPORS

(Continued)

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological
77. Platinum	8	N	N		
29. Potassium	33	1.6E-2	N	a	
84. Praseodymium	<0.3	N	N		
Rhenium	<0.3	N	N		
75. Rhodium	<0.3	N	N		
30. Rubidium	<0.3	N	N		
73. Ruthenium	<0.3	N	N		
84. Samarium	<0.3	N	N		
60. Scandium	<0.2	<3E-6	N	g	
54. Selenium	<0.3	<2E-3	N	a	
43. Silicon	505	N	N		
79. Silver	≤0.3	≤3E-2	N	a	
28. Sodium	<163	N	N		
35. Strontium	<8	<3E-3	N	g	
53. Sulfur	34	N	N		
67. Tantalum	<0.3	N	N		
55. Tellurium	<0.3	<3E-3	N	a	
Terbium	<0.3	N	N		
41. Thallium	<0.3	<3E-3	N	a	
85. Thorium	<3	<4E-1	N	h	
Thulium	<0.3	N	N		
45. Tin	<0.3	N	N		
62. Titanium	38	6.3E-3	N	a	
70. Tungsten	<0.3	<3E-4	N	a	
85. Uranium	<3	<4E-1	N	h	
65. Vanadium	<0.3	<7E-4	<3E-1	a	a
Ytterbium	<0.3	N	N		
61. Yttrium	<1	N	N		
81. Zinc	<34	<8.5E-3	N	a	
63. Zirconium	≤1	N	N		
Total Discharge Severity =		3E0	3E-1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-18. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR DOWNWIND VAPORS

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological	MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological
38. Aluminum	>103	>2.0E-2	N	a		39. Gallium	<0.4	<8E-5	N	g	
47. Ammonia						44. Germanium	<0.4	<7E-4	N	a	
50. Antimony	<0.2	<3E-4	N	a		80. Gold	<0.2	N	N		
49. Arsenic	0.4	2E-1	N	c		64. Hafnium	<0.2	N	N		
36. Barium	8	2E-2	N	a		Holmium	<0.2	N	N		
32. Beryllium	<0.2	<8E-2	N	a		59. Iodine	<0.3	N	N		
51. Bismuth	<0.2	<4E-4	N	a		Iridium	<0.2	N	N		
37. Boron	0.3	1E-4	N	a		72. Iron	703	N	N		
58. Bromine	<2	N	N			84. Lanthanum	2	N	N		
82. Cadmium	<0.2	<2E-2	N	a		46. Lead	<2	<1E-2	N	a	
34. Calcium	262	N	N			27. Lithium	0.2	7E-3	N	a	
84. Cerium	<2	N	N			Lutecium	<0.2	N	N		
31. Cesium	0.4	N	N			33. Magnesium	<72	<1E-2	N	a	
57. Chlorine	26	N	N			71. Manganese	27	5.3E-3	N	c	
68. Chromium	61	6.1E1	N	c		83. Mercury	<0.06	1E-3	<6E-3	c	c
74. Cobalt	24	5E-1	N	a		69. Molybdenum	11	2.3E-3	N	a	
78. Copper	125	6.3E-1	N	a		84. Neodymium	0.3	N	N		
84. Dysprosium	<0.2	N	N			76. Nickel	*	*	N		
Erbium	<0.2	N	N			66. Niobium	<2	N	N		
Europium	<0.2	N	N			Osmium	<0.2	N	N		
56. Fluorine	≈3	N	N			Palladium	<0.2	N	N		
Gadolinium	<0.2	N	N			48. Phosphorus	38	3.8E-1	N	a	

* Possible contamination of the blank and therefore discharge severity not calculated.

TABLE 5-18. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR DOWNWIND VAPORS

(Continued)

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	2	N	N			67. Tantalum	<0.2	N	N		
29. Potassium	<471	<2.4E-1	N	a		55. Tellurium	<0.2	<2E-3	N	a	
84. Praseodymium	0.4	N	N			Terbium	<0.2	N	N		
Rhenium	<0.2	N	N			41. Thallium	<0.2	<2E-3	N	a	
75. Rhodium	<0.2	N	N			85. Thorium	<2	<2E-1	N	h	
30. Rubidium	<0.2	N	N			Thulium	<0.2	N	N		
73. Ruthenium	<0.2	N	N			45. Tin	<0.2	N	N		
84. Samarium	<0.2	N	N			62. Titanium	11	1.9E-3	N	a	
60. Scandium	<0.2	<3E-6	N	g		70. Tungsten	<0.2	<2E-4	N	a	
54. Selenium	<0.2	<8E-4	N	a		85. Uranium	<1	<1E-1	N	h	
43. Silicon	129	N	N			65. Vanadium	<2	<3E-3	<2E0	a	a
79. Silver	1	1E-1	N	a		Ytterbium	<0.2	N	N		
28. Sodium	>148	N	N			61. Yttrium	<0.2	N	N		
35. Strontium	<8	<3E-3	N	g		81. Zinc	<33	<8.2E-3	N	a	
53. Sulfur	247	N	N			63. Zirconium	<0.2	N	N		

Total Discharge Severity = 6E1 2E0

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

5.2.3 Liquid Waste Streams

Samples of seven liquid waste streams were taken at coal preparation plant No. 1, including plant feedwater, pondwater from the three sedimentation ponds, and runoff from the ROM coal, clean coal, and coarse refuse piles. Another liquid waste stream was produced by filtering the fine refuse slurry. Leachates were also generated from most solids and are discussed in Section 5.2.3.

The eight liquid waste streams were analyzed for inorganic chemical composition using both Inductively Coupled Plasma (ICP) and Spark Source/Mass Spectrophotometer (SSMS), extractable organics (except plant feedwater), and biological response. The results of these analyses and the SAM/1A evaluation of the inorganic constitutent results are presented below. Classical water quality parameter results and discussions are provided in Section 5.2.5.

5.2.3.1 Plant Feedwater--

The SAM/1A evaluation of the inorganic elements and biological test results are summarized in Table 5-19. As indicated by the table this stream has no inorganic constituents with a health-based DS greater than 1, and, in fact, the TDS is less than 1. In contrast, the ecological-based TDS is about 10, with ammonia, cadmium, and silver having DS values greater than one. The individual DS values are provided in Table 5-20. Consistent with the SAM/1A evaluation, the health-related Ames assay and CHO clonal assay showed low or non-detectable effects. Note that the plant feedwater is taken from the surface of pond No. 3.

5.2.4.2 Pond No. 1 Water--

The TDS values for this stream, as determined by the SAM/1A evaluation, are 2 (health-based) and 30 (ecological-based). The major contributors to the ecological-realted TDS are ammonia, cadmium, and silver, as indicated in Tables 5-21 and 5-22. Also, Table 5-21 shows that the health-related biological tests (using unfiltered pond water) revealed low or nondetectable effects for the Ames assay, but moderate effects for the CHO clonal assay (EC_{50} = 63 μℓ/mℓ). Unfiltered pond waters (i.e., ponds No. 1, 2, and 3) were

TABLE 5-19. SUMMARY OF CHEMICAL TEST RESULTS FOR FEEDWATER FILTRATE AND BIOASSAY TEST RESULTS FOR UNFILTERED FEEDWATER

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			
$10^2 - 10^3$			HEALTH Ames Negative µℓ/mℓ CHO (EC_{50}) >600 nontoxic
$10 - 10^2$	No Discharge Severity Values Greater Than 1		
$1 - 10$		Cd, Ag, NH_3-N	ECOLOGICAL Tests not conducted.

TABLE 5-20 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR FEEDWATER FILTRATE

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
ICP DATA											
18. Aluminum	60	7.5E-4	6.0E-2	a	c	33. Magnesium	2,530	2.8E-2	2.9E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	9	4E-2	9E-2	c	c
49. Arsenic	N.R.					33. Mercury	N.R.				
36. Barium	20	4.0E-3	8.0E-3	c	c	69. Molybdenum	31	4.1E-4	4.4E-3	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	365	7.8E-3	1.5E-2	a	c	29. Potassium	2,900	9.6E-2	6.7E-2	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.			c	c
34. Calcium	11,300	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E 0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	138,000	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	62	1.3E-3	N	g	N
78. Copper	<1	<2E-4	<2E-2	c	c	45. Tin	58	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	175	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	5	2E-2	1E-2	a	c	81. Zinc	<2	<8E-5	<2E-2	c	c
SSMS DATA											
47. Ammonia	<100	<4E-2	<2E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	<1	<4E-3	<2E-2	c	c	48. Phosphate	123	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	20	N	N	N	N	84. Praseodymium	2	N	N	N	N
84. Cerium	10	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	2,000	N	N	N	N	30. Rubidium	3	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≈0.8	N	N	N	N	54. Selenium	5	1E-1	2E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	3,000	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	6,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	4	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	10	N	N	N	N	85. Thorium	≤8	≤1E-4	≤2E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	0.2	2E-2	8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<3	N	N			85. Uranium	≤7	≤1E-4	≤1E-2	h	c
66. Niobium	<1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	6	N	N	N	N

Total Discharge Severity = 7E-1 1E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-21. SUMMARY OF CHEMICAL TEST RESULTS FOR POND WATER #1 FILTRATE AND BIOASSAY TEST RESULTS FOR UNFILTERED POND WATER #1

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$				
$10^2 - 10^3$	No Discharge Severity Value Greater Than 1.		**HEALTH**	
			Ames	Negative
			CHO (EC_{50})	63 µℓ/mℓ
$10 - 10^2$		NH_3-N		
			***ECOLOGICAL**	
$1 - 10$		Cd, Ag	Aquatic Bioassay-Fish (LC_{50}, 96-hr)	>100%; nontoxic
			Aquatic Bioassay-Invertebrate (EC_{50},48-hr)	>100%; nontoxic
			Aquatic Bioassay-Alga	
			• EC_{50}, 12-day	63.0%
			• EC_{50}, 17-day	57.0%
			• EC_{50}, 21-day	11.5%

*Composite of Ponds #1-3 unfiltered water.

TABLE 5-22 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND WATER #1 FILTRATE

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
ICP DATA											
38. Aluminum	280	3.5E-3	2.8E-1	a	c	33. Magnesium	3,240	3.6E-2	3.7E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	7	3E-2	7E-2	c	c
49. Arsenic	N.R.			c	c	83. Mercury	N.R.				
36. Barium	65	1.3E-2	2.6E-2	c	c	69. Molybdenum	73	9.7E-4	1.0E-2	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	6	3E-2	6E-1	a	c
37. Boron	578	1.2E-2	2.3E-2	a	c	29. Potassium	9,900	3.3E-1	2.3E-1	a	a
82. Cadmium	<2	<4E-2	<2E 0	c	c	54. Selenium	N.R.			c	c
34. Calcium	32,400	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E 0	c	c
68. Chromium	4	2E-2	2E-2	c	c	28. Sodium	295,000	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	158	3.4E-3	N	g	n
78. Copper	2	4E-4	4E-2	c	c	45. Tin	50	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	3	3E-5	4E-3	a	c
72. Iron	125	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	18	5.5E-2	4.8E-2	a	c	81. Zinc	8	3E-4	8E-2	c	c
SSMS DATA											
47. Ammonia	1,200	5E-1	2E1	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤4	≤2E-2	≤8E-2	c	c	48. Phosphate	215	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	40	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	5,000	N	N	N	N	30. Rubidium	20	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	≤1	≤1E-6	N	g	N
56. Fluorine	≈4,000	N	N	N	N	54. Selenium	10	2E-1	4E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	1,000	N	N	N	N
44. Germanium	<1	<1E-5	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	<6,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	4	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	≤8	≤1E-4	≤2E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	≤7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	≤8	≤1E-4	≤2E-2	h	c
66. Niobium	<1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<1	N	N	N	N
						Total Discharge Severity =		2E0	7E1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

composited for ecological-based biological assessments. The composite showed low or nondetectable effects on fish and invertebrates and moderate effects on algae. More specifically, fifty percent of the algae polulation (EC_{50}) was effected in test media containing 63.0 percent, 57.0 percent, and 11.5 percent concentrations of sample for 12-, 17-, and 21-day exposures, respectively.

The total extractable organics value from a filtered sample was 600 μg/ℓ, consisting of no detectable chromatographable organics and 600 μg/ℓ, of gravimetrically determined constituents.

5.2.3.3 Pond No. 2 Water--

Table 5-23 summarizes the SAM/1A evaluation of inorganic constituents in pond No. 2 water and the biological assessment results. The health-based TDS is less than 1 and the ecological-based TDS is about 10. The contributors with DS values greater than one are again ammonia, cadmium, and silver. The individual DS values are provided in Table 5-24. The health-based biological tests showed low or nondetectable effects for the Ames assay and a moderate effects level for the CHO clonal assay, with an EC_{50} of 79 μℓ/ml.

The TCO and Grav results, based on a filtered sample, were 500 μg/ℓ. As with pond No. 1, the only measureable value was from the gravimetric analysis.

5.2.3.4 Pond No. 3 Water--

The SAM/1A evaluation results for this water are quite similar to pond No. 2, with a health-based TDS of about 1 and an ecological-based TDS of about 15. As with ponds No. 1 and 2, ammonia, cadmium, and silver contribute to the ecological-based TDS as well as aluminum (See Tables 5-25 and 5-26). The bioassay results, also shown in Table 5-25, reveal that the health-related tests show a negative response to the Ames assay and a moderate effect in the CHO clonal assay. The EC_{50} for the CHO test was 126 μℓ/mℓ.

There was a slight increase in the gravimetric results for this filtered pond water, compared to the other ponds, producing a TCO + Grav value of 1,000 μg/ℓ. Again, no TCO was detected.

TABLE 5-13. SUMMARY OF CHEMICAL TEST RESULTS FOR POND WATER #2 FILTRATE AND BIOASSAY TEST RESULTS FOR UNFILTERED POND WATER #2

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			HEALTH Ames Negative CHO (EC_{50}) 79 µℓ/mℓ
$10^2 - 10^3$	No Discharge Severity Values Greater Than 1		
$10 - 10^2$			
1 - 10		Cd, Ag, NH_3-N	*ECOLOGICAL See Unfiltered Pond Water #1. *Composite of Ponds #1-3 unfiltered water.

TABLE 5-24 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND WATER #2 FILTRATE

ICP DATA

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	220	2.8E-3	2.2E-1	a	c	33. Magnesium	1,600	1.8E-2	1.8E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	3	1E-2	3E-2	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	55	1.1E-2	2.2E-2	c	c	69. Molybdenum	76	1.0E-3	1.1E-2	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	584	1.2E-2	2.3E-2	a	c	29. Potassium	4,400	1.5E-1	1.0E-1	a	a
82. Cadmium	2	4E-2	2E0	c	c	54. Selenium	N.R.				
34. Calcium	12,600	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	236,000	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-2	c	c	35. Strontium	82	1.8E-3	N	g	N
78. Copper	<1	<2E-4	<2E-2	c	c	45. Tin	23	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	1	1E-5	1E-3	a	c
72. Iron	88	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	14	4.2E-2	3.7E-2	a	c	81. Zinc	<2	<8E-5	<2E-2	c	c
SSMS DATA											
47. Ammonia	<100	<4E-2	<2E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤1	≤4E-3	≤2E-2	c	c	48. Phosphate	184	*	*	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	100	N	N	N	N	84. Prasecdymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	3,000	N	N	N	N	30. Rubidium	7	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≈300	N	N	N	N	54. Selenium	2	4E-2	8E-2	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	3,000	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>2,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	7	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	≤3	≤5E-5	≤6E-3	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	6	1E-4	1E-2	h	c
66. Niobium	<1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<1	N	N	N	N

Total Discharge Severity = 7E-1   1E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-25. SUMMARY OF CHEMICAL TEST RESULTS FOR POND WATER #3 FILTRATE AND BIOASSAY TEST RESULTS FROM UNFILTERED POND WATER #3

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
10^3 - 10^4				
10^2 - 10^3			HEALTH	
	No Discharge Severity Values Greater Than 1		Ames	Negative
			CHO (EC_{50})	126 µl/ml
10 - 10^2				
			* ECOLOGICAL	
1 - 10		Al, Cd, Ag, NH_3-N	See Unfiltered Pond Water #1.	

*Composite of Ponds #1-3 unfiltered water.

TABLE 5-26 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR PONDWATER #3 FILTRATE

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc) Health	Discharge Severity (Estimated Conc/DMEG Conc) Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
ICP DATA					
38. Aluminum	2,700	3.4E-2	2.7E0	a	c
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c
49. Arsenic	N.R.	N	N	c	c
36. Barium	37	7.4E-3	1.5E-2	c	c
32. Beryllium	<1	<3E-2	<2E-2	a	c
37. Boron	190	4.0E-3	7.6E-3	a	c
82. Cadmium	<2	<4E-2	<2E0	c	c
34. Calcium	13,700	N	N	N	N
68. Chromium	4	2E-2	2E-2	c	c
74. Cobalt	<2	<3E-3	<8E-2	c	c
78. Copper	2	4E-4	4E-2	c	c
39. Gallium	<20	<2.7E-4	N	g	n
72. Iron	1,790		N	N	N
46. Lead	<30	<1.2E-1	<6.0E-1	c	c
27. Lithium	7	2E-2	2E-2	a	c
33. Magnesium	3,140	3.5E-2	3.6E-2	a	e
71. Manganese	52	2.1E-1	5.2E-1	c	c
83. Mercury	N.R.	N	N	N	N
69. Molybdenum	40	5.3E-4	5.7E-4	a	c
76. Nickel	<5	<2E-2	<5E-1	a	c
29. Potassium	4,000	1.3E-1	9.3E-2	a	a
54. Selenium	N.R.	N	N	c	c
79. Silver	<30	<1.2E-1	<6.0E0	c	c
28. Sodium	147,000	N	N	N	N
35. Strontium	73	1.6E-3	N	g	n
45. Tin	34	N	N	N	N
62. Titanium	12	1.3E-4	1.5E-2	a	c
65. Vanadium	<5	<2E-3	<3E-2	a	e
61. Yttrium	<1	N	N	N	N
81. Zinc	5	2E-4	5E-2	c	c
SSMS DATA					
47. Ammonia	≤100	≤4E-2	<2E0	c	e
49. Arsenic	2	8E-3	4E-2	c	c
51. Bismuth	<1	<2E-4	N	a	N
58. Bromine	30	N	N	N	N
84. Cerium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N
57. Chlorine	2,000	N	N	N	N
84. Dysprosium	<1	N	N	N	N
Erbium	<1	N	N	N	N
Europium	<1	N	N	N	N
56. Fluorine	≈6,000	N	N	N	N
Gadolinium	<1	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N
80. Gold	<1	N	N	N	N
64. Hafnium	<1	N	N	N	N
Holmium	<1	N	N	N	N
59. Iodine	20	N	N	N	N
Iridium	<1	N	N	N	N
84. Lanthanum	<1	N	N	N	N
Lutecium	<1	N	N	N	N
83. Mercury	≤0.2	≤2E-2	≤8E-4	c	c
84. Neodymium	<1	N	N	N	N
66. Niobium	1	N	N	N	N
Osmium	<1	N	N	N	N
Palladium	<1	N	N	N	N
48. Phosphate	184	N	N	a	c
77. Platinum	<1	N	N	N	N
84. Praseodymium	<1	N	N	N	N
Rhenium	<1	N	N	N	N
75. Rhodium	<1	N	N	N	N
30. Rubidium	20	N	N	N	N
73. Ruthenium	<1	N	N	N	N
84. Samarium	<1	N	N	N	N
60. Scandium	<1	<1E-6	N	g	N
54. Selenium	5	1E-1	2E-1	c	c
43. Silicon	7,000	N	N	N	N
53. Sulfur	>5,000	N	N	N	N
67. Tantalum	<1	N	N	N	N
55. Tellurium	<1	<7E-4	N	a	N
Terbium	<1	N	N	N	N
41. Thallium	<1	<7E-4	N	a	N
85. Thorium	≤7	≤1E-4	≤1E-2	h	c
Thulium	<1	N	N	N	N
70. Tungsten	<1	<7E-5	N	a	N
85. Uranium	≤6	≤1E-4	≤1E-2	h	c
Ytterbium	<1	N	N	N	N
63. Zirconium	2	N	N	N	N
Total Discharge Severity =		1E0	2E1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

5.2.3.5 ROM Coal Pile Runoff--

The results of the SAM/1A evaluation of the inorganic results and biological tests are summarized in Table 5-27. As indicated, the health TDS, which has a value of 2, has no compound with a DS greater than or equal to 1. The ecological TDS is about 30 and the major contributors are ammonia, cadmium, manganese, and nickel. Individual DS values are shown on Table 5-28.

The ROM coal pile runoff biological tests were health-related only. The assay was negative and the CHO clonal assay had low or nondetectable effects (i.e., EC_{50} is 600 $\mu\ell/m\ell$).

The TCO + Grav concentration was 3,300 $\mu g/\ell$ and consisted entirely of gravimetrically determined, extractable organics. There was no attempt to identify the organics nor perform a SAM/1A evaluation.

5.2.3.6 Clean Coal Pile Runoff--

Table 5-29 summarizes the SAM/1A evaluation for inorganic constituents and the bioassay results. The health TDS was about 10 and the ecological TDS was about 100. For both TDS values the major contributors were manganese and ammonia, with nickel also contributing significantly to the ecological TDS result. Individual DS values for inorganic constituents are presented in Table 5-30.

The health-related biological tests showed low or nondetectable effects for the assay and CHO clonal assay.

The TCO + Grav value for the clean coal runoff was considerably lower than other runoff streams at 600 $\mu g/\ell$. The gravimetric test contributed all of the extractable organics measured.

5.2.3.7 Coarse Refuse Runoff--

The SAM/1A evaluation, summarized in Table 5-31 and detailed in Table 5-32, resulted in a health-based TDS of 9 and an ecological TDS of 40. The major contributor to both TDS values is manganese. Ammonia, cadmium, nickel, and silver also contribute to the ecological-based TDS. The bioassay results, also summarized in Table 5-31, show low or nondetectable effects for the health-related Ames and CHO clonal assays.

TABLE 5-27. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR ROM STORAGE PILE RUNOFF

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$				
$10^2 - 10^3$	No Discharge Severity Values Greater Than 1.		HEALTH	
			Ames	Negative
			CHO (EC_{50})	>600 µℓ/mℓ; nontoxic
$10 - 10^2$		NH_3-N		
			ECOLOGICAL	
1 - 10		Ag, Cd, Mn, Ni	Tests not conducted.	

TABLE 5-28 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR ROM STORAGE PILE RUNOFF

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
ICP DATA											
38. Aluminum	80	1.0E-3	8.0E-2	a	c	33. Magnesium	23,500	2.6E-1	2.7E-1	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	146	5.8E-1	1.5E0	c	c
49. Arsenic	N.R.			c	c	83. Mercury	N.R.				
36. Barium	58	1.2E-2	2.3E-2	c	c	69. Molybdenum	≤4	≤5E-5	<6E-4	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	12	5.2E-2	1.2E0	a	c
37. Boron	167	3.6E-3	6.7E-3	a	c	29. Potassium	4,300	1.4E-1	1.0E-1	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.			c	c
34. Calcium	130,000	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	7	3E-2	3E-2	c	c	28. Sodium	125,000	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-2	c	c	35. Strontium	482	1.0E-2	N	g	N
78. Copper	2	4E-4	4E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	3	3E-5	4E-3	a	c
72. Iron	51	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	3	9E-3	8E-3	a	c	81. Zinc	19	7.6E-4	1.9E-1	c	c
SSMS DATA											
47. Ammonia	800	3E-1	2E1	c	e	Palladium	<2	N	N	N	N
49. Arsenic	≤8	≤3E-2	≤2E-1	c	c	48. Phosphate	245	N	N	a	c
51. Bismuth	<2	<3E-4	N	a	N	77. Platinum	<2	N	N	N	N
58. Bromine	40	N	N	N	N	84. Praseodymium	<2	N	N	N	N
84. Cerium	<2	N	N	N	N	Rhenium	<2	N	N	N	N
31. Cesium	<2	N	N	N	N	75. Rhodium	<2	N	N	N	N
57. Chlorine	5,000	N	N	N	N	30. Rubidium	<2	N	N	N	N
84. Dysprosium	<2	N	N	N	N	73. Ruthenium	<2	N	N	N	N
Erbium	<2	N	N	N	N	84. Samarium	<2	N	N	N	N
Europium	<2	N	N	N	N	60. Scandium	≤2	≤3E-6	N	g	N
56. Fluorine	≈2,000	N	N	N	N	54. Selenium	<2	<4E-2	<8E-2	c	c
Gadolinium	<2	N	N	N	N	43. Silicon	300	N	N	N	N
44. Germanium	<2	<2E-4	N	a	N						
80. Gold	<2	N	N	N	N	53. Sulfur	>10,000	N	N	N	N
64. Hafnium	<2	N	N	N	N	67. Tantalum	<2	N	N	N	N
Holmium	<2	N	N	N	N	55. Tellurium	<2	<1E-3	N	a	N
59. Iodine	≤2	N	N	N	N	Terbium	<2	N	N	N	N
Iridium	<2	N	N	N	N	41. Thallium	<2	<1E-3	N	a	N
84. Lanthanum	<2	N	N	N	N	85. Thorium	≤20	≤3E-4	≤4E-2	h	c
Lutecium	<2	N	N	N	N	Thulium	<2	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<2	<1E-4	N	a	N
84. Neodymium	<2	N	N	N	N	85. Uranium	≤10	≤2E-4	≤2E-2	h	c
66. Niobium	<2	N	N	N	N	Ytterbium	<2	N	N	N	N
Osmium	<2	N	N	N	N	63. Zirconium	4	N	N	N	N

Total Discharge Severity = 2E0 3E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-29. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR CLEAN COAL STORAGE PILE RUNOFF

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			HEALTH Ames Negative CHO (EC_{50}) >600 μℓ/mℓ; nontoxic
$10^2 - 10^3$			
$10 - 10^2$		Mn, Ni, NH_3-N	
$1 - 10$	Mn, NH_3-N	Cd, Ag, Zn	ECOLOGICAL Tests not conducted.

TABLE 5-30 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR CLEAN COAL STORAGE PILE RUNOFF

ICP DATA

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	190	2.4E-3	1.9E-1	a	c	33. Magnesium	57,900	6.4E-1	6.7E-1	a	e
50. Antimony	36	4.8E-3	1.8E-1	a	c	71. Manganese	1,900	7.6E0	1.9E1	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	41	8.2E-3	1.6E-2	c	c	69. Molybdenum	<4	<5E-5	<6E-4	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	144	6.3E-1	1.4E1	a	c
37. Boron	1,012	2.2E-2	4.0E-2	a	c	29. Potassium	4,000	1.3E-1	9.3E-2	a	a
82. Cadmium	8	2E-1	8E0	c	c	54. Selenium	N.R.				
34. Calcium	508,000	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	20	8.0E-2	8.0E-2	c	c	28. Sodium	305,000	N	N	N	N
74. Cobalt	68	9.1E-2	2.7E-1	c	c	35. Strontium	2,362	5.1E-2	N	g	N
78. Copper	10	2.0E-3	2.0E-1	c	c	45. Tin	N	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	7	8E-5	9E-3	a	c
72. Iron	47	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	9	N	N	N	N
27. Lithium	13	3.9E-2	3.5E-2	a	c	81. Zinc	351	1.4E-2	3.5E0	c	c
						SSMS DATA					
47. Ammonia	2,500	1E0	5E1	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤0.3	≤1E-3	≤6E-3	c	c	48. Phosphate	31	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	200	N	N	N	N	34. Praseodymium	3	N	N	N	N
84. Cerium	20	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	>10,000	N	N	N	N	30. Rubidium	<1	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≈200	N	N	N	N	54. Selenium	4	8E-2	2E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	1,000	N	N	N	N
44. Germanium	3	2E-1	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>4,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	<1	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	70	N	N	N	N	85. Thorium	300	5E-3	6E-1	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	0.2	2E-2	8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	6	N	N	N	N	85. Uranium	<1	<2E-5	<2E-3	h	c
66. Niobium	≤1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	5	N	N	N	N
						Total Discharge Severity =		1E1	1E2		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-31. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR COARSE REFUSE PILE RUNOFF

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$			HEALTH	
$10^2 - 10^3$			Ames	Negative
			CHO (EC_{50})	>600 µℓ/mℓ; nontoxic
$10 - 10^2$		Mn		
			ECOLOGICAL	
$1 - 10$	Mn	Cd, Ni, Ag, NH_3-N	Tests not conducted.	

TABLE 5-32 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE PILE RUNOFF

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
ICP DATA											
38. Aluminum	940	1.2E-2	9.4E-1	a	c	33. Magnesium	14,800	1.6E-1	1.7E-1	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	2,010	8.0E0	2.0E1	c	c
49. Arsenic	N.R.			c	c	83. Mercury	N.R.				
36. Barium	42	8.4E-3	1.7E-2	c	c	69. Molybdenum	36	4.8E-4	5.1E-3	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	24	1.0E-1	2.4E0	a	c
37. Boron	424	9.0E-3	1.7E-2	a	c	29. Potassium	6,400	2.1E-1	1.5E-1	a	a
82. Cadmium	2	4E-2	2E 0	c	c	54. Selenium	N.R.			c	c
34. Calcium	93,700	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	14	5.6E-2	5.6E-2	c	c	28. Sodium	454,000	N	N	N	N
74. Cobalt	8	1E-2	3E-2	c	c	35. Strontium	505	1.1E-2	N	g	N
78. Copper	8	2E-3	2E-1	c	c	45. Tin	196	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	16	1.8E-4	2.0E-2	a	c
72. Iron	601	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	1	N	N	N	N
27. Lithium	27	8.2E-2	7.2E-2	a	c	81. Zinc	<2	<8E-5	<2E-2	c	c
SSMS DATA											
47. Ammonia	400	2E-1	8E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤3	≤1E-2	≤6E-2	c	c	48. Phosphate	90	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	60	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	4,000	N	N	N	N	30. Rubidium	6	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	1E-6	N	q	N
56. Fluorine	~2,000	N	N	N	N	54. Selenium	≤8	≤2E-1	≤3E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	600	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>4,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	30	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	≤6	≤1E-4	≤1E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<3E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	10	2E-4	2E-2	h	c
66. Niobium	2	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	1	N	N	N	N

Total Discharge Severity = 9E0 4E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

The 2,000 μg/ℓ value for TCO + Grav consisted entirely of gravimetrically determined, extractable organics. This value is midway between the ROM and clean coal runoff extractable organics value.

5.2.3.8 Fine Waste Slurry Filtrate--

The fine waste slurry was separated into its solid and liquid components for trace element determination. A summary of the filtrate trace element analysis is provided in Table 5-33. The health-based TDS for the filtrate was calculated to have a value of 11 which was caused primarily by the ammonia DS value. The ecological-based TDS was equal to about 70, with ammonia the major contributor to that value. Much smaller contributions were derived from Cd and Ag. Individual trace element concentrations and DS values are shown on Table 5-34.

The extractable organic value was equal to 700 μg/ℓ. No chromatographable organic constituents were detected, however.

Biological assessments were not conducted on the filtrate.

5.2.4 Solid and Leachate Waste Streams

Seven solid waste streams were sampled at coal preparation plant No. 1: filtered solids from the fine refuse waste slurry, coarse refuse, ROM coal, clean coal, and pond sediments from pond Nos. 1, 2, and 3. Except for fine refuse wastes, a leachate was generated from each solid sample as well. The solid samples and their leachates were analyzed for trace elements and biological activity. In addition, the pond sediments and leachates were analyzed for extractable organics. These results are presented here and in the TCO + Grav discussion (Section 5.2.4). Classical water quality parameter results are presented in the additional Water Quality Tests Section (Section 5.2.5).

TABLE 5-33. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR FINE WASTE SLURRY FILTRATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			HEALTH Tests not conducted.
$10^2 - 10^3$			
$10 - 10^2$	NH_3-N	NH_3-N	
1 - 10		Cd, Ag	ECOLOGICAL Tests not conducted.

TABLE 5-34 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR FINE WASTE SLURRY FILTRATE

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc) Health	Discharge Severity Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological	MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc) Health	Discharge Severity Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
ICP DATA											
88. Aluminum	190	2.4E-3	1.9E-1	a	c	33. Magnesium	6,720	7.5E-2	7.7E-2	a	e
50. Antimony	10	1.3E-3	5.0E-2	a	c	71. Manganese	75	3.0E-1	7.5E-1	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	18	3.6E-3	7.2E-3	c	c	69. Molybdenum	39	5.2E-4	5.6E-3	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	8	3E-2	8E-1	a	c
17. Boron	685	1.5E-2	2.7E-2	a	c	29. Potassium	9,900	3.3E-1	2.3E-1	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	72,800	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	11	4.4E-2	4.4E-2	c	c	28. Sodium	375,000	N	N	N	N
74. Cobalt	3	4E-3	1E-2	c	c	35. Strontium	335	7.3E-3	N	g	N
78. Copper	3	6E-4	6E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	4	4E-5	5E-3	a	c
72. Iron	182	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	29	8.8E-2	7.7E-2	a	c	81. Zinc	<2	<8E-5	<2E-2	c	c
SSMS DATA											
47. Ammonia	3,000	1E1	6E1	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤4	≤2E-2	≤8E-2	c	c	48. Phosphate	60	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	200	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	>110,000	N	N	N	N	30. Rubidium	7	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	≤1	<1E-6	N	g	N
56. Fluorine	≈100	N	N	N	N	54. Selenium	10	2E-5	4E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	700	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>6,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	10	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	≤8	≤1E-4	≤2E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	≤7	≤1E-4	≤1E-2	h	c
66. Niobium	≤1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<1	N	N	N	N

Total Discharge Severity = 1E1 7E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

5.2.4.1 Fine Refuse Waste Solids--

The SAM/1A evaluation results for the inorganic tests are provided in Table 5-35. As indicated in this table, the health-based TDS for inorganics is 560, while the ecological-based TDS is approximately 10,040. The major contributor to the high ecological-based TDS is phosphorus which has an individual DS of 1×10^4. For the health-based TDS, the major contributors are Mn and Cr.

Table 5-36 summarizes the major contributors to the TDS and the results of the biological screening tests. The health-related bioassay tests (i.e., Ames, RAM, and Rodent Acute Toxicity), which were performed on the slurry rather than the filtered solids (except for the Ames test, which was performed on both), show low or nondetectable effects. However, the ecological-related aquatic bioassays showed moderate effects on invertebrates (i.e., Daphnia magna) and algae and low or nondetectable effects on fish. The EC_{50} value for 48 hours for the Daphnia magna was 74.5 percent, and for the algae was 64.0, 60.0, and 21.0 percent for 12, 17, and 21 days, respectively.

5.2.4.2 Coarse Refuse--

Table 5-37 presents the SAM/1A evaluation for inorganics measured in the coarse refuse. The health-based TDS for this stream is about 700 and the ecological-based TDS is 10,030. As in the fine refuse waste solids, the main contributor to the ecological-based TDS are phosphorus and nickel, and to the health-based TDS is Mn and Cr. Lead and selenium also contribute significant (i.e., about 10 percent each) to the health-based TDS.

A summary of the major contributors to the TDS values and the biological screening test results is provided in Table 5-38. For the coarse refuse, health-related bioassay tests (i.e., Ames and RAM) were conducted. The Ames test showed low or nondetectable effects; however, the RAM assay showed a moderate response. The RAM assay EC_{50} was 112 μg/mℓ, based on percent phagocytosis.

5.2.4.3 Coarse Refuse Leachate--

For coarse refuse leachate, the health-based TDS was 3 and the ecological-based TDS was about 40. The latter value reflected a significant DS

TABLE 5-35 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR FILTERED SOLIDS FROM THE FINE WASTE SLURRY

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>150	>9.4E-1	>7.5E-1	a	c	39. Gallium	12	8.0E-2	N	d	
47. Ammonia						44. Germanium	3	2E-1	N	a	
50. Antimony	0.9	6E-2	2E-2	a	c	80. Gold	<0.1	N	N		
49. Arsenic	3	6E0	3E-1	c	c	64. Hafnium	<0.1	N	N		
36. Barium	360	3.6E1	7.2E-1	c	c	Holmium	<0.1	N	N		
32. Beryllium	3	5E1	3E-1	a	c	59. Iodine	0.7	N	N		
51. Bismuth	<0.1	<8E-3	N	g		Iridium	<0.1	N	N		
37. Boron	110	1.2E0	2.2E-2	a	c	72. Iron	<1,000	N	N		
58. Bromine	1	N	N			84. Lanthanum	16	N	N		
82. Cadmium	3	3E1	2E1	d	c	46. Lead	3	6E0	3E-1	c	c
34. Calcium	>1,000	N	N			27. Lithium	21	3.0E1	2.8E-1	a	c
84. Cerium	22	N	N		.	Lutecium	<0.1	N	N		
31. Cesium	2	N	N			33. Magnesium	>1,000	>5.6E0	>5.7E-2	a	e
57. Chlorine	85	N	N			71. Manganese	76	1.5E2	3.8E0	c	c
68. Chromium	76	1.5E2	1.5E0	c	c	83. Mercury	<0.04	<2E0	<8E-4	c	c
74. Cobalt	3	2E0	6E-2	a	c	69. Molybdenum	4	3E-2	3E-3	a	e
78. Copper	9	9E-1	9E-1	a	a	84. Neodymium	7	N	N		
84. Dysprosium	<0.1	N	N			76. Nickel	3	7E0	2E0	a	c
Erbium	<0.1	N	N			66. Niobium	8	N	N		
Europium	0.4	N	N			Osmium	<0.1	N	N		
56. Fluorine	>230	N	N			Palladium	<0.1	N	N		
Gadolinium	0.4	N	N			48. Phosphorus	>1,000	>3.3E1	>1.0E4	a	c

TABLE 5-35 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR FILTERED SOLIDS FROM THE FINE WASTE SLURRY

(CONTINUED)

MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological
77. Platinum	<0.1	N	N		
29. Potassium	>1,000	N	N		
84. Praseodymium	3	N	N		
Rhenium	< 0.1	N	N		
75. Rhodium	<0.1	N	N		
30. Rubidium	130	N	N		
73. Ruthenium	<0.1	N	N		
84. Samarium	1	N	N		
60. Scandium	4	3E-3	N	g	
54. Selenium	2	2E1	4E-1	c	c
43. Silicon	>1,000	N	N		
79. Silver	<0.1	<2E-1	<1E-1	c	c
28. Sodium	>380	N	N		
35. Strontium	60	6.5E-1	N	g	
53. Sulfur	>930	N	N		
67. Tantalum	<0.1	N	N		
55. Tellurium	0.3	1E-1	N	a	
Terbium	<0.1	N	N		
41. Thallium	<0.1	<3E-2	N	a	
85. Thorium	3	3E-2	3E-2	h	c
Thulium	<0.1	N	N		
45. Tin	0.5	N	N		
62. Titanium	>1,000	>5.6E0	>6.3E0	a	e
70. Tungsten	<0.1	<3E-3	N	a	
85. Uranium	1	8E-3	1E-2	h	c
65. Vanadium	110	2.2E1	3.6E0	a	e
Ytterbium	<0.1	N	N		
61. Yttrium	12	N	N		
81. Zinc	10	2E-1	5E-1	c	c
63. Zirconium	43	N	N		

Total Discharge Severity = 6E2 1E4

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-36. SUMMARY OF CHEMICAL TEST RESULTS FOR FILTERED SOLIDS FROM FINE WASTE SLURRY AND BIOASSAY TEST RESULTS FROM UNFILTERED FINE WASTE SLURRY

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$		P		
$10^2 - 10^3$	Cr, Mn		**HEALTH**	
			Ames	
			• Whole Material	Negative
			• Filtered Solids	Negative
			RAM (EC_{50})	>300µℓ/mℓ (% phagocytosis) >300µℓ/mℓ (nmol ATP/well)
$10 - 10^2$	Ba, Be, Cd, Li, P, Se, V	Cd	Rodent Acute (LD_{50})	>10 g/kg rat; nontoxic
			ECOLOGICAL	
			Aquatic Bioassay - Fish (LC_{50}, 96-hr)	>100%; nontoxic
1 - 10	As, B, Co, Pb, Mg, Ni, Ti	Cr, Ni, Ti, Mn, V	Aquatic Bioassay - Invertebrate (EC_{50}, 48-hour)	74.5% (0.95 confidence interval = 61.1 - 102.9%)
			Aquatic Bioassay - Alga	
			• EC_{50}, 12-day	64.0 %
			• EC_{50}, 17-day	60.0%
			• EC_{50}, 21-day	21.0%

TABLE 5-37 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>45	>2.8E-1	>2.3E-1	a	c	39. Gallium	33	2.2E-1	N	d	
47. Ammonia						44. Germanium	0.8	5E-1	N		
50. Antimony	0.9	6E-2	2E-2	a	c	80. Gold	<0.1	N	N		
49. Arsenic	9	2E1	9E-1	c	c	64. Hafnium	3	N	N		
36. Barium	480	4.8E1	9.6E-1	c	c	Holmium	0.5	N	N		
32. Beryllium	0.6	1E1	6E-2	a	c	59. Iodine	0.2	N	N		
51. Bismuth	<0.1	<8E-3	N	g		Iridium	<0.1	N	N		
37. Boron	17	1.8E-1	3.4E-3	a	c	72. Iron	1,000	N	N		
58. Bromine	9	N	N			84. Lanthanum	21	N	N		
82. Cadmium	0.8	8E0	4E0	d	c	46. Lead	36	7.2E1	3.6E0	c	c
34. Calcium	1,000	N	N			27. Lithium	16	2.3E1	2.1E-1	a	c
84. Cerium	58	N	N			Lutecium	<0.1	N	N		
31. Cesium	<0.1	N	N			33. Magnesium	1,000	5.6E0	5.7E-2	a	e
57. Chlorine	>110	N	N			71. Manganese	150	3.0E2	7.5E0	c	c
68. Chromium	51	1.0E2	1.0E0	c	c	83. Mercury	0.15	7.5E0	3.0E-3	c	c
74. Cobalt	3	2E0	6E-2	a	c	69. Molybdenum	2	1.3E-2	1.4E-3	a	e
78. Copper	15	1.5E0	1.5E0	a	a	84. Neodymium	20	N	N		
84. Dysprosium	0.9	N	N			76. Nickel	4	9E0	2E1	a	c
Erbium	0.2	N	N			66. Niobium	10	N	N		
Europium	0.7	N	N			Osmium	<0.1	N	N		
56. Fluorine	≈400	N	N			Palladium	<0.1	N	N		
Gadolinium	1	N	N			48. Phosphorus	1,000	3.3E1	1E4	a	c

TABLE 5-37 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE

(CONTINUED)

MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological
77. Platinum	0.1	N	N		
29. Potassium	1,000	N	N		
84. Praseodymium	10	N	N		
Rhenium	<0.1	N	N		2
75. Rhodium	<0.1	N	N		
30. Rubidium	39	N	N		
73. Ruthenium	<0.1	N	N		
84. Samarium	4	N	N		
60. Scandium	3	2E-3	N	g	
54. Selenium	6	6E1	1E0	c	c
43. Silicon	1,000	N	N		
79. Silver	<0.1	<2E-1	<1E-1	c	c
28. Sodium	>110	N	N		
35. Strontium	32	3.5E-1	N	g	
53. Sulfur	>280	N	N		
67. Tantalum	≤0.4	N	N		
55. Tellurium	0.1	3E-2	N	a	
Terbium	0.2	N	N		
41. Thallium	2	7E-1	N	a	
85. Thorium	5	4E-2	5E-2	h	c
Thulium	<0.1	N	N		
45. Tin	1	N	N		
62. Titanium	1,000	5.6E0	6.3E0	a	e
70. Tungsten	0.4	1E-2	N	a	
85. Uranium	2	2E-2	2E-2	h	c
65. Vanadium	85	1.7E1	2.8E0	a	e
Ytterbium	0.5	N	N		
61. Yttrium	7	N	N		
81. Zinc	30	6E-1	2E0	c	c
63. Zirconium	73	N	N		
Total Discharge Severity =		7E2	1E4		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-38. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR COARSE REFUSE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
10^3 - 10^4		P	HEALTH Ames Negative RAM (EC_{50}) 112 µg/mℓ (% phagocytosis) 251 µg/mℓ (nmol ATP/well) ECOLOGICAL Tests not conducted.
10^2 - 10^3	Cr, Mn		
10 - 10^2	As, Ba, Be, Pb, Li, P Se, V		
1 - 10	Cd, Co, Cu, Mg, Ni, Ti	Cd, Cr, Cu, Pb, Mn, Se, Ti, V, Zn	

value for ammonia. The SAM/1A evaluation for inorganics is summarized in Table 5-39. The specific DS values for each element are presented in Table 5-40.

The health-related biological assessment for coarse refuse leachate showed little or nondetectable effects for the Ames assay and CHO clonal assay. This leachate was combined with ROM and clean coal leachate for ecological-related aquatic bioassays. There were little or nondetectable effects for fish and invertebrates, but the EC_{50} values for algae of 23.0 percent, 11.0 percent, and 15.5 percent for 12, 17, and 21 days of exposure, respectively, reflect a moderate effect.

The TCO + Grav analysis showed TCO at less than detectable limits of 2 mg and gravimetric concentrations at less than the detection limit of 4 mg; therefore, no detectable extractable, organic material was found.

5.2.4.4 ROM Coal and ROM Coal Leachate--

Feed coal was sampled and analyzed for inorganic chemical content (Appendix A), proximate and ultimate content (Section 5.2.5), and leachable material. The inorganic chemical analysis SAM/1A evaluation of the leachate had a health-based TDS of 1 and an ecological-based TDS of 30. As with the coarse refuse, the major contributor to the ecological-based TDS was ammonia. The TDS and biological assessment results are summarized in Table 5-41. The individual DS values are given in Table 5-42.

The ROM coal and leachate were tested for health effects, and little or nondetectable effects were found using Ames assay (both streams), RAM assay (ROM coal), and CHO clonal assay (leachate) tests. The test results of ecological-related effects on the leachate are presented above in the coarse refuse leachate results, because a leachate composite was used in these tests.

The extractable organics were measured in the laboratory samples at the detection limit of 2 mg for TCO and 4 mg for gravimetric. This is equivalent to a concentration in the leachate of 1,500 μg/ℓ of extractable organics.

TABLE 5-39. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR COARSE REFUSE LEACHATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis: Health	Compounds Found from Chemical Analysis: Ecological	Bioassay Test Results	
$10^3 - 10^4$				
$10^2 - 10^3$				
			HEALTH	
			Ames	Negative
			CHO (EC_{50})	>600 μℓ/mℓ; nontoxic
$10 - 10^2$		NH_3-N		
			* **ECOLOGICAL**	
$1 - 10$		Cd, Ag, Se	Aquatic Bioassay - Fish (LC_{50})	>100%; nontoxic
			Aquatic Bioassay - Invertebrate (EC_{50}, 48-hr)	>100%; nontoxic
			Aquatic Bioassay - Alga	
			● EC_{50}, 12-day	23.0%
			● EC_{50}, 17-day	11.0%
			● EC_{50}, 21-day	15.5%

*Composite of ROM, clean coal, and coarse refuse leachates.

TABLE 5-40 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR COARSE REFUSE LEACHATE

ICP DATA

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	<10	<1.3E-4	<1.0E-2	a	c	33. Magnesium	1,480	1.6E-2	1.7E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	21	8.4E-2	2.1E-1	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	<20	<4.0E-3	<8.0E-3	c	c	69. Molybdenum	357	4.8E-3	5.1E-2	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	557	1.2E-2	2.2E-2	a	c	29. Potassium	11,400	3.8E-1	2.7E-1	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	14,973	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	33,192	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	121	2.6E-3	N	g	N
78. Copper	<1	<2E-4	<2E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	14	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	31	9.4E-2	8.3E-2	a	c	81. Zinc	54	2.2E-3	5.4E-1	c	c
						SSMS DATA					
47. Ammonia	1,360	5.4E-1	2.7E1	c	e	Palladium	<1	N	N	N	N
49. Arsenic	<1	<4E-3	<2E-2	c	c	48. Phosphate	<300	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	60	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	<100	N	N	N	N	30. Rubidium	20	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≈200	N	N	N	N	54. Selenium	30	6E-1	1E0	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	<2,000	N	N	N	N
44. Germanium	<1	<1E-5	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>3,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	<1	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	<40	<7E-4	<8E-2	h	c
66. Niobium	<1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<5	N	N	N	N

Total Discharge Severity = 2E0 4E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-41. SUMMARY OF CHEMICAL TEST RESULTS FOR ROM COAL LEACHATES AND BIOASSAY TEST RESULTS FOR ROM COAL AND ROM COAL LEACHATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			
$10^2 - 10^3$	No Discharge Severity Values Greater Than 1.		HEALTH (Leachate) Ames Negative CHO (EC_{50}) >600 µℓ/mℓ ; nontoxic (Coal) Ames Negative RAM (EC_{50}) 370 µg/mℓ (% phagocytosis) >1,000 µg/mℓ (nmol ATP/well)
$10 - 10^2$		NH_3-N	
$1 - 10$		Cd, Ag	* ECOLOGICAL See Course Refuse Leachate Results.

*Composite of ROM, clean coal, and coarse refuse leachates.

TABLE 5-42 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR ROM COAL LEACHATE

ICP DATA

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	<10	<1.3E-4	<1.0E-2	a	c	33. Magnesium	2,360	2.6E-2	2.7E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	58	2.3E-1	5.8E-1	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	24	4.8E-3	9.6E-3	c	c	69. Molybdenum	<5	<7E-5	<7E-4	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	444	9.4E-3	1.8E-2	a	c	29. Potassium	8,800	2.9E-1	2.0E-1	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	38,873	N	N	N	N	79. Silver	30	1.2E-1	6.0E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	174,792	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	160	3.5E-3	N	g	N
78. Copper	<1	<2E-4	<2E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	<10	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	17	5.2E-2	4.5E-2	a	c	81. Zinc	<12	<4.8E-4	<1.2E-1	c	c
						SSMS DATA					
47. Ammonia	830	3.3E-1	1.7E1	c	e	Palladium	<1	N	N	N	N
49. Arsenic	≤1	<4E-3	<2E-2	c	c	48. Phosphate	<300	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	50	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	500	N	N	N	N	30. Rubidium	9	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	1E-6	N	g	N
56. Fluorine	≈700	N	N	N	N	54. Selenium	6	1E-1	2E-1	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	<2,000	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>6,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	≤6	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	<1	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	<10	<2E-4	<2E-2	h	c
66. Niobium	1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<5	N	N	N	N

Total Discharge Severity = 1E0 3E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

5.2.4.5 Clean Coal and Clean Coal Leachate—

Similar to the ROM coal, inorganic chemical analyses (Appendix A), proximate and ultimate analyses (Section 5.2.5), and leachable chemical analyses were performed on the clean coal. The health-based TDS for inorganic leachable constituents was 3 and the ecological-based TDS for those chemicals was 30. Only manganese had a health-based DS value greater than one. There were five constituents other than manganese that contributed to the ecological-based TDS value. A summary of the TDS value and biological assessment of the clean coal and leachate is provided in Table 5-43. The DS values for each element are listed in Table 5-44.

The clean coal and clean coal leachate were tested for health effects. The Ames assay showed little or no detectable effects from the clean coal, and the CHO clonal assay resulted in no detectable effect from the leachate. The ecological-related bioassay results for the leachate are presented in the coarse refuse leachate discussion.

The TCO + Grav analyses for extractable organics showed no detectable concentrations.

5.2.4.6 Pond Sediment—

Sediment samples from the three sedimentation ponds (in series) were analyzed for inorganic constituents, total extractable organic content, and biological response. A summary of the major inorganic TDS values and biological results are provided as Table 5-45 through 5-47.

The health-based TDS values for the sediments in ponds No. 1, 2, and 3 were 2,450, 550, and 800, respectively. For pond No. 1 the significant contributors (i.e., a DS >100) to the TDS are strontium, chromium, and manganese; for pond No. 2 they are barium and manganese; and for pond No. 3, manganese. The ecological-based TDS values ranged from 10,000 for pond No. 1 to about 3,100 for the other two ponds. Although these values are higher than the health-based TDS, only phosphorus was a significant contributor to the ecological-based TDS results. The individual SAM/1A evaluation results are provided in Tables 5-48, 5-49, and 5-50.

The TCO + Grav results for extractable organics were 864, 199, and 85 mg/g, respectively, for ponds No. 1, 2, and 3. Since the sediments

TABLE 5-43. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR CLEAN COAL LEACHATE AND CLEAN COAL

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results		
	Health	Ecological			
$10^3 - 10^4$					
$10^2 - 10^3$				HEALTH	
			(Leachate)	Ames	Negative
				CHO(EC$_{50}$)	>600 μℓ/mℓ; nontoxic
			(Coal)	Ames	Negative
$10 - 10^2$				RAM (EC$_{50}$)	457 μg/mℓ (%phagocytosis)
				* ECOLOGICAL	
1 - 10	Mn	Cd, Mn, Ni, Ag, Zn, NH_3-N	See Coarse Refuse Leachate Fesults.		
			*Composite of ROM, clean coal, and coarse refuse leachates.		

TABLE 5-44 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR CLEAN COAL LEACHATE

ICP DATA

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological	MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological
38. Aluminum	<20	<2.5E-4	<2.0E-2	a	c	33. Magnesium	3,880	4.3E-2	4.5E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	561	2.2E0	5.6E0	c	c
49. Arsenic	N.R.					33. Mercury	N.R.				
36. Barium	26	5.2E-3	1.0E-2	c	c	69. Molybdenum	<4	<5E-5	<6E-4	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	20	8.7E-2	2.0E0	a	c
37. Boron	323	6.9E-3	1.3E-2	a	c	29. Potassium	4,200	1.4E-1	9.8E-2	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	118,473	N	N	N	N	79. Silver	<30	<1.2E-1	<6.0E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	60,392	N	N	N	N
74. Cobalt	9	<1E-2	<4E-2	c	c	35. Strontium	266	5.8E-3	N	g	N
78. Copper	1	<2E-4	<2E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	<8	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	<10	<3E-2	<3E-2	a	c	81. Zinc	157	6.3E-3	1.6E0	c	c
SPARK SOURCE DATA											
47. Ammonia	440	1.8E-1	8.8E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	<1	<4E-3	<2E-2	c	c	48. Phosphate	<300	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	60	N	N	N	N	84. Prasecodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chloride	200	N	N	N	N	30. Rubidium	3	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<2	<3E-6	N	g	N
56. Fluoride	<980	N	N	N	N	54. Selenium	2	4E-2	8E-2	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	<2,000	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>9,900	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodide	<1	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	<10	<2E-4	<2E-2	h	c
66. Niobium	<1	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	≤5	N	N	N	N

Total Discharge Severity = 3E0 3E1

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-45. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #1 SEDIMENT

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$	Sr	P	HEALTH Ames Negative *RAM (EC_{50}) 372 µg/mℓ (% phagocytosis) 447 µg/mℓ (nmol ATP/well) *Composite of Ponds #1-3 Sediment. ECOLOGICAL Tests not conducted.
$10^2 - 10^3$	Cr, Mn		
$10 - 10^2$	As, Ba, Pb, Li, Ni, P, Se, V	Mn	
1 - 10	Al, Be, Cd, Cu, Mg, Co, Ti, Zn	As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Ti, V, Zn	

TABLE 5-46. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #2 SEDIMENT

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results	
	Health	Ecological		
$10^3 - 10^4$		P		
$10^2 - 10^3$	Ba, Mn		**HEALTH**	
			Ames	Negative
			*RAM (EC_{50})	372 μg/mℓ (% phagocytosis) 447 μg/mℓ (nmol ATP/well)
$10 - 10^2$	Cr, Pb, Ni, P, Se		* Composite of Ponds #1-3 Sediment.	
$1 - 10$	As, Be, Cd, Li, Mg Ti, V	Ba, Cd, Ti, V, Zn, Mn, Ni	**ECOLOGICAL** Tests not conducted.	

TABLE 5-47. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #3 SEDIMENT

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$		P	HEALTH Ames — Negative *RAM (EC_{50}) — 372 μg/mℓ (% phagocytosis) 447 μg/mℓ (nmol ATP/well) * Composite of Ponds #1-3 Sediment.
$10^2 - 10^3$	Mn		
$10 - 10^2$	As, Ba, Cd, Cr, Pb, Li, Ni, P, V	Mn	
$1 - 10$	Be, Cu, Mg, Se, Ti, Zn	Ba, Cd, Cu, Pb, Ni, Ti, V, Zn	ECOLOGICAL Tests not conducted.

TABLE 5-48 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #1 SEDIMENT

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>190	>1.2E0	>9.5E-1	a	c	39. Gallium	63	4.2E-1	N	d	
47. Ammonia						44. Germanium	2	1E-1	N	a	
50. Antimony	0.7	5E-2	2E-2	a	c	80. Gold	<0.2	N	N		
49. Arsenic	18	3.6E1	1.8E0	c	c	64. Hafnium	5	N	N		
36. Barium	510	5.1E1	1.0E0	c	c	Holmium	2	N	N		
32. Beryllium	0.3	5E0	3E-2	a	c	59. Iodine	2	N	N		
51. Bismuth	<0.2	<2E-2	N	g		Iridium	<0.2	N	N		
37. Boron	18	1,9E-1	3.6E-3	a	c	72. Iron	>1,000	N	N		
58. Bromine	7	N	N			84. Lanthanum	200	N	N		
82. Cadmium	<0.2	<2E0	<1E0	d	c	46. Lead	35	7.0E1	3.5E0	c	c
34. Calcium	>1,000	N	N			27. Lithium	27	3.9E1	3.6E-1	a	c
84. Cerium	250	N	N			Lutecium	<0.2	N	N		
31. Cesium	7	N	N			33. Magnesium	>1,000	>5.6E0	>5.7E-2	a	c
57. Chlorine	110	N	N			71. Manganese	240	4.8E2	1.2E1	c	c
68. Chromium	54	1.1E2	1.1E0	c	c	83. Mercury	<0.04	<2E0	<8E-4	c	c
74. Cobalt	6	4E0	1E-1	a	c	69. Molybdenum	5	3E-2	4E-3	a	e
78. Copper	26	2.6E0	2.6E0	a	a	84. Neodymium	21	N	N		
84. Dysprosium	4	N	N			76. Nickel	8	2E1	4E0	a	c
Erbium	2	N	N			66. Niobium	24	N	N		
Europium	1	N	N			Osmium	<0.2	N	N		
56. Fluorine	>1,000	N	N			Palladium	<0.2	N	N		
Gadolinium	5	N	N			48. Phosphorus	>1,000	>3.3E1	>1.0E4	a	c

TABLE 5-48 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #1 SEDIMENT

(CONTINUED)

MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological	MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological
77. Platinum	<0.2	N	N			67. Tantalum	<0.2	N	N		
29. Potassium	1,000	N	N			55. Tellurium	0.6	2E-1	N	a	
84. Praseodymium	25	N	N			Terbium	0.8	N	N		
Rhenium	<0.2	N	N			41. Thallium	2	7E-1	N	a	
75. Rhodium	<0.2	N	N			85. Thorium	36	3.0E-1	3.6E-1	h	c
30. Rubidium	41	N	N			Thulium	<0.2	N	N		
73. Ruthenium	<0.2	N	N			45. Tin	1	N	N		
84. Samarium	18	N	N			62. Titanium	>1,000	>5.6E0	>6.3E0	a	e
60. Scandium	5	3E-3	N	g		70. Tungsten	1	3E-2	N	a	
54. Selenium	6	6E1	1E0	c	c	85. Uranium	15	1.3E-1	1.5E-1	h	c
43. Silicon	1,000	N	N			65. Vanadium	64	1.3E1	2.1E0	a	e
79. Silver	<0.2	<4E-1	<2E-1	c	c	Ytterbium	<0.2	N	N		
28. Sodium	>480	N	N			61. Yttrium	62	N	N		
35. Strontium	140	1.5E3	N	g		81. Zinc	12	2.4E0	6.0E0	c	c
Sulfur	1,000	N	N			63. Zirconium	120	N	N		

Total Discharge Severity = 2E3 1E4

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-49. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #2 SEDIMENT

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>45	>2.8E-1	>2.3E-1	a	c	39. Gallium	7	5E-2	N	d	
47. Ammonia						44. Germanium	0.3	2E-2	N	a	
50. Antimony	0.3	2E-2	8E-3	a	c	80. Gold	<0.1	N	N		
49. Arsenic	4	3E0	4E-1	c	c	64. Hafnium	5	N	N		
36. Barium	>1,000	>1E2	>2E0	c	c	Holmium	0.5	N	N		
32. Beryllium	0.2	3E0	2E-2	a	c	59. Iodine	0.5	N	N		
51. Bismuth	<0.1	<8E-3	N	g		Iridium	<0.1	N	N		
37. Boron	4	4E-2	8E-4	a	c	72. Iron	>1,000	N	N		
58. Bromine	4	N	N			84. Lanthanum	21	N	N		
82. Cadmium	0.3	3E0	2E0	d	c	46. Lead	8	2E1	8E-1	c	c
34. Calcium	>1,000	N	N			27. Lithium	3	4E0	4E-2	a	c
84. Cerium	26	N	N			Lutecium	<0.1	N	N		
31. Cesium	2	N	N			33. Magnesium	>1,000	>5.6E0	>5.7E-2	a	e
57. Chlorine	11	N	N			71. Manganese	150	3.0E2	7.5E0	c	c
68. Chromium	23	4.6E1	4.6E-1	c	c	83. Mercury	<0.04	<2E0	<8E-4	c	c
74. Cobalt	0.9	6E-1	2E-2	a	c	69. Molybdenum	1	7E-3	7E-4	a	e
78. Copper	6	6E-1	6E-1	a	a	84. Neodymium	5	N	N		
84. Dysprosium	0.9	N	N			76. Nickel	8	2E1	4E0	a	c
Erbium	0.2	N	N			66. Niobium	23	N	N		
Europium	0.6	N	N			Osmium	<0.1	N	N		
56. Fluorine	≈160	N	N			Palladium	<0.1	N	N		
Gadolinium	1	N	N			48. Phosphorus	310	1.0E1	3.1E3	a	c

TABLE 5-49. SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #2 SEDIMENT

(continued)

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
77. Platinum	<0.1	N	N			67. Tantalum	≤0.4	N	N		
29. Potassium	>1,000	N	N			55. Tellurium	<0.1	<3E-2	N	a	
84. Praseodymium	5					Terbium	0.2	N	N		
Rhenium	<0.1	N	N			41. Thallium	0.2	7E-2	N	a	
75. Rhodium	<0.1	N	N			85. Thorium	5.0	4E-2	5E-2	h	c
30. Rubidium	40	N	N			Thulium	<0.1	N	N		
73. Ruthenium	<0.1	N	N			45. Tin	0.4	N	N		
84. Samarium	4	N	N			62. Titanium	>1,000	>5.6E0	>6.3E0	a	e
60. Scandium	7	4E-3	N	g		70. Tungsten	0.2	7E-3	N	a	
54. Selenium	1	1E1	2E-1	c	c	85. Uranium	2	2E-2	2E-2	h	c
43. Silicon	>1,000	N	N			65. Vanadium	34	6.8E0	1.1E0	a	e
79. Silver	<0.1	<2E-1	<1E-1	c	c	Ytterbium	0.5	N	N		
28. Sodium	>110	N	N			61. Yttrium	15	N	N		
35. Strontium	72	7.8E-1	N	g		81. Zinc	30	6E-1	2E0	c	c
53. Sulfur	93	N	N			63. Zirconium	>1,000	N	N		

Total Discharge Severity = 6E2 3E3

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-50 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #3 SEDIMENT

MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (μg/g)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
38. Aluminum	>76	>4.8E-1	>3.8E-1	a	c	39. Gallium	11	7.3E-2	N	d	
47. Ammonia						44. Germanium	0.4	2.4E-2	N	a	
50. Antimony	1	7E-2	3E-2	a	c	80. Gold	<0.1	N	N		
49. Arsenic	7	1E1	7E-1	c	c	64. Hafnium	6	N	N		
36. Barium	810	8.1E1	1.6E0	c	c	Holmium	0.9	N	N		
32. Beryllium	0.1	2E0	9E-3	a	c	59. Iodine	0.9	N	N		
51. Bismuth	<0.1	<8E-3	N	g		Iridium	<0.1	N	N		
37. Boron	7	8E-2	1E-3	a	c	72. Iron	>1,000	N	N		
58. Bromine	7	N	N	d		84. Lanthanum	20	N	N		
82. Cadmium	1	1E1	5E0		c	46. Lead	14	2.8E1	1.4E0	c	c
34. Calcium	>1,000	N	N			27. Lithium	11	1.6E1	1.5E-1	a	c
84. Cerium	44	N	N			Lutecium	0.4	N	N		
31. Cesium	1	N	N			33. Magnesium	>1,000	>5.6E0	>5.7E-2	a	e
57. Chlorine	17	N	N			71. Manganese	260	5.2E2	1.3E1	c	c
68. Chromium	35	7.0E1	7.0E-1	c	c	83. Mercury	<0.04	<2E0	<8E-4	c	c
74. Cobalt	0.1	7E-2	2E-3	a	c	69. Molybdenum	2	1.3E-2	1.4E-3	a	e
78. Copper	10	1.0E0	1.0E0	a	a	84. Neodymium	8	N	N		
84. Dysprosium	1	N	N			76. Nickel	8	1.8E1	4.0E0	a	c
Erbium	0.7	N	N			66. Niobium	16	N	N		
Europium	1	N	N			Osmium	<0.1	N	N		
56. Fluorine	≈120	N	N			Palladium	<0.1	N	N		
Gadolinium	2	N	N			48. Phosphorus	330	1.1E1	3.3E3	a	c

TABLE 5-50 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #3 SEDIMENT

(continued)

MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological	MEG Category	Estimated Concentration (µg/g)	Discharge Severity (Estimated Conc/ DMEG Conc) Health	Ecological	Basis for DMEG Value Health	Ecological
77. Platinum	<0.1	N	N			67. Tantalum	<0.1	N	N •		
29. Potassium	>1,000	N	N			55. Tellurium	<0.1	<3E-2	N	a	
84. Praseodymium	3	N	N			Terbium	0.3	N	N		
Rhenium	<0.1	N	N			41. Thallium	<0.1	<3E-2	N	a	
75. Rhodium	<0.1	N	N			85. Thorium	14	1.2E-1	1.4E-1	h	c
30. Rubidium	66	N	N			Thulium	0.2	N	N		
73. Ruthenium	<0.1	N	N			45. Tin	<0.1	N	N		
84. Samarium	4	N	N			62. Titanium	>1,000	>5.6E0	>6.3E0	a	e
60. Scandium	4	2.5E-3	N	g		70. Tungsten	<0.1	<3E-3	N	a	
54. Selenium	0.9	9.0E0	1.8E-1	c	c	85. Uranium	7	5.8E-2	7.0E-2	h	c
43. Silicon	1,000	N	N			65. Vanadium	57	1.1E1	1.9E0	a	e
79. Silver	<0.1	<2E-1	<1E-1	c	c	Ytterbium	2	N	N		
28. Sodium	>190	N	N			61. Yttrium	2.5	N	N		
35. Strontium	54	5.9E-1	N	g		81. Zinc	50	1.0E0	2.5E0	c	c
53. Sulfur	52	N	N			63. Zirconium	49	N	N		
						Total Discharge Severity =		8E2	3E3		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

contain fine coal material, and this material is expected to settle out as water overflows through the successive ponds, the decreasing value of the TDS from pond No. 1 to pond No. 3 is not surprising.

Pond sediments were only tested for health-related biological response. The results for each Ames assay and the composite RAM assay showed little or nondetectable effects.

5.2.4.7 Pond Sediment Leachate--

Each sediment sample was tested for leaching characteristics. The leachate health-based TDS values were quite low and were 2, 2, and 4 for ponds No. 1, 2, and 3, respectively. The ecological-based TDS values were slightly higher at 20, 10, and 20 for the three ponds in series. Ammonia in pond No. 2 was the only ecological-based TDS contributor with a DS greater than 10 in any of the ponds (See Tables 5-51, 5-52, and 5-53). Manganese was the only significant contributor to the health-based TDS in all three ponds (DS>1). The SAM/1A evaluations of the leachates are shown in Tables 5-54, 5-55, and 5-56.

The TCO + Grav results also reflect a reduced amount of coal particles in the overflow ponds. The pond sediment leachate for ponds No. 2 and 3 are at or below the detection limit of 1 mg/ℓ. The extractable, organics concentration of the leachate from pond No. 1 sediment was measured at 2.3 mg/ℓ, of which about 200 μg/ℓ are chromatographable organics.

Health-related biological assessments of the pond sediment leachates revealed little or nondetectable effects for individual Ames assays or the (composite) CHO clonal assay. Ecological-related aquatic bioassays showed that the leachate composite produced little or nondetectable responses on fish and invertebrates, but a moderate effect was found during algal tests. The EC_{50} values for the algal test of pond sediment leachate were 10.5 percent, 13.5 percent, and 10.5 percent for 12, 17, and 21 days of exposure, respectively.

5.2.5 Additional Chemical/Physical Tests--

This section presents additional analytical results that were not presented in the previous sections; data are included for both process and waste streams sampled.

TABLE 5-51. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #1 SEDIMENT LEACHATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			
$10^2 - 10^3$			**HEALTH** Ames — Negative *CHO (EC_{50}) — >600 µℓ/mℓ; nontoxic
$10 - 10^2$			
1 - 10	Mn	Ag, Cd, Mn, NH_3-N	***ECOLOGICAL** Aquatic Bioassay-Fish (LC_{50}, 96-hr) — >100%; nontoxic Aquatic Bioassay-Invertebrate (EC_{50}, 48-hr) — >100%; nontoxic Aquatic Bioassay-Alga ● EC_{50}, 12-day — 10.5% ● EC_{50}, 17-day — 13.0% ● EC_{50}, 21-day — 10.5% *Composite of Ponds #1-3 Sediment Leachates.

TABLE 5-52. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #2 SEDIMENT LEACHATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			
$10^2 - 10^3$			HEALTH Ames Negative *CHO (EC_{50}) >600 µℓ/mℓ; nontoxic
$10 - 10^2$		NH_3-N	
1 - 10	Mn	Cd, Mn, Ag	*ECOLOGICAL See Pond #1 Sediment Leachate Results.

*Composite of Ponds #1-3 Sediment Leachates.

TABLE 5-53. SUMMARY OF CHEMICAL AND BIOASSAY TEST RESULTS FOR POND #3 SEDIMENT LEACHATE

Discharge Severity Range (upper limit not inclusive)	Compounds Found from Chemical Analysis		Bioassay Test Results
	Health	Ecological	
$10^3 - 10^4$			
$10^2 - 10^3$			HEALTH Ames Negative *CHO (EC_{50}) >600 µℓ/mℓ; nontoxic
$10 - 10^2$			
$1 - 10$	Mn	Cd, Mn, Ag, NH_3-N	* ECOLOGICAL See Pond #1 Sediment Leachate Results.

*Composite of Ponds #1-3 sediment leachates.

TABLE 5-54 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #1 SEDIMENT LEACHATE

MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value		MEG Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc/ DMEG Conc)		Basis for DMEG Value	
		Health	Ecological	Health	Ecological			Health	Ecological	Health	Ecological
ICP DATA											
38. Aluminum	<10	<1.3E-4	<1.0E-2	a	c	33. Magnesium	5,207	5.8E-2	6.0E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	276	1.1E0	2.8E0	c	c
49. Arsenic	N.R.					83. Mercury	N.R.				
36. Barium	80	1.6E-2	3.2E-2	c	c	69. Molybdenum	42	6E-4	6E-3	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	469	1.0E-2	1.9E-2	a	c	29. Potassium	6,200	2.1E-1	1.4E-1	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	38,273	N	N	N	N	79. Silver	<30	<1.2E-1	<6E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	99,336	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	173	3.8E-3	N	g	N
78. Copper	<3	<6E-4	<6E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	15	N	N	N	N	65. Vanadium	<5	<2E-3	<3.3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	1	N	N	N	N
27. Lithium	<5	<2E-2	<1.3E-2	a	c	81. Zinc	84	3E-3	8E-1	c	c
SSMS DATA											
47. Ammonia	190	7.6E-2	3.8E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	<3	<1E-2	<6E-2	c	c	48. Phosphate	9	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	54	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	<200	N	N	N	N	30. Rubidium	5	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≈980	N	N	N	N	54. Selenium	2	4E-2	8E-2	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	230	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>5,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	<1	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	<10	<2E-4	<2E-2	h	c
66. Niobium	<4	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<30	N	N	N	N
						Total Discharge Severity =		2E0	2E1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-55 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #2 SEDIMENT LEACHATE

MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc) Health	Discharge Severity (Estimated Conc/DMEG Conc) Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological	MEG Category	Estimated Concentration (μg/ℓ)	Discharge Severity (Estimated Conc/DMEG Conc) Health	Discharge Severity (Estimated Conc/DMEG Conc) Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
ICP DATA											
38. Aluminum	<30	<3.8E-4	<3.0E-2	a	c	33. Magnesium	1,777	2E-2	2E-2	a	e
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c	71. Manganese	316	1E0	3E0	c	c
49. Arsenic	N.R.					33. Mercury	N.R.				
36. Barium	21	4E-3	8E-3	c	c	69. Molybdenum	<20	<3E-4	<3E-3	a	e
32. Beryllium	<1	<3E-2	<2E-2	a	c	76. Nickel	<5	<2E-2	<5E-1	a	c
37. Boron	156	3.3E-3	6.2E-3	a	c	29. Potassium	1,200	4.0E-2	2.8E-2	a	a
82. Cadmium	<2	<4E-2	<2E0	c	c	54. Selenium	N.R.				
34. Calcium	7,593	N	N	N	N	79. Silver	<30	<1.2E-1	<6E0	c	c
68. Chromium	<2	<8E-3	<8E-3	c	c	28. Sodium	49,836	N	N	N	N
74. Cobalt	<2	<3E-3	<8E-3	c	c	35. Strontium	37	8E-4	N	g	N
78. Copper	<2	<4E-4	<4E-2	c	c	45. Tin	<10	N	N	N	N
39. Gallium	<20	<2.7E-4	N	g	N	62. Titanium	<1	<1E-5	<1E-3	a	c
72. Iron	28	N	N	N	N	65. Vanadium	<5	<2E-3	<3E-2	a	e
46. Lead	<30	<1.2E-1	<6.0E-1	c	c	61. Yttrium	<1	N	N	N	N
27. Lithium	<1	<3E-3	<3E-3	a	c	81. Zinc	<20	<8E-3	<2E-1	c	c
SSMS DATA											
47. Ammonia	110	4.4E-2	2.2E0	c	e	Palladium	<1	N	N	N	N
49. Arsenic	<3	<1E-2	<6E-2	c	c	48. Phosphate	9	N	N	a	c
51. Bismuth	<1	<2E-4	N	a	N	77. Platinum	<1	N	N	N	N
58. Bromine	<4	N	N	N	N	84. Praseodymium	<1	N	N	N	N
84. Cerium	<1	N	N	N	N	Rhenium	<1	N	N	N	N
31. Cesium	<1	N	N	N	N	75. Rhodium	<1	N	N	N	N
57. Chlorine	<200	N	N	N	N	30. Rubidium	<1	N	N	N	N
84. Dysprosium	<1	N	N	N	N	73. Ruthenium	<1	N	N	N	N
Erbium	<1	N	N	N	N	84. Samarium	<1	N	N	N	N
Europium	<1	N	N	N	N	60. Scandium	<1	<1E-6	N	g	N
56. Fluorine	≥180	N	N	N	N	54. Selenium	2	4E-2	8E-2	c	c
Gadolinium	<1	N	N	N	N	43. Silicon	930	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N						
80. Gold	<1	N	N	N	N	53. Sulfur	>4,000	N	N	N	N
64. Hafnium	<1	N	N	N	N	67. Tantalum	<1	N	N	N	N
Holmium	<1	N	N	N	N	55. Tellurium	<1	<7E-4	N	a	N
59. Iodine	8	N	N	N	N	Terbium	<1	N	N	N	N
Iridium	<1	N	N	N	N	41. Thallium	<1	<7E-4	N	a	N
84. Lanthanum	<1	N	N	N	N	85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Lutecium	<1	N	N	N	N	Thulium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c	70. Tungsten	<1	<7E-5	N	a	N
84. Neodymium	<1	N	N	N	N	85. Uranium	<10	<2E-4	<2E-2	h	c
66. Niobium	<3	N	N	N	N	Ytterbium	<1	N	N	N	N
Osmium	<1	N	N	N	N	63. Zirconium	<30	N	N	N	N

Total Discharge Severity = 2E0 121

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

TABLE 5-56 SUMMARY OF TEST RESULTS AND DISCHARGE SEVERITY VALUES FOR POND #3 SEDIMENT LEACHATE

ICP DATA

NO. Category	Estimated Concentration (µg/ℓ)	Discharge Severity (Estimated Conc./ DMEG Conc.) Health	Discharge Severity Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
88. Aluminum	<50	<6.3E-4	<5.0E-2	a	c
50. Antimony	<10	<1.3E-3	<5.0E-2	a	c
49. Arsenic	N.R.				
36. Barium	15	3E-3	6E-3	c	c
32. Beryllium	<1	<3E-2	<2E-2	a	c
37. Boron	60	1E-3	2E-3	a	c
82. Cadmium	<2	<4E-2	<2E0	c	c
34. Calcium	7,069	N	N	N	N
68. Chromium	<2	<8E-3	<8E-3	c	c
74. Cobalt	<2	<3E-3	<8E-3	c	c
78. Copper	<2	<4E-4	<4E-2	c	c
39. Gallium	<20	<2.7E-4	N	g	N
72. Iron	48	N	N	N	N
46. Lead	<30	<1.2E-1	<6.0E-1	c	c
27. Lithium	<1	<3E-3	<3E-3	a	c
47. Ammonia	140	5.6E-2	2.8E0	c	e
49. Arsenic	<1	<4E-3	<2E-2	c	c
51. Bismuth	<1	<2E-4	N	a	N
58. Bromine	14	N	N	N	N
84. Cerium	1	N	N	N	N
31. Cesium	<1	N	N	N	N
57. Chlorine	<200	N	N	N	N
84. Dysprosium	<1	N	N	N	N
Erbium	<1	N	N	N	N
Europium	<1	N	N	N	N
56. Fluorine	<280	N	N	N	N
Gadolinium	<1	N	N	N	N
44. Germanium	<1	<1E-4	N	a	N
80. Gold	<1	N	N	N	N
64. Hafnium	<1	N	N	N	N
Holmium	<1	N	N	N	N
59. Iodine	10	N	N	N	N
Iridium	<1	N	N	N	N
84. Lanthanum	<1	N	N	N	N
Lutecium	<1	N	N	N	N
83. Mercury	<0.2	<2E-2	<8E-4	c	c
84. Neodymium	<1	N	N	N	N
66. Niobium	<3	N	N	N	N
Osmium	<1	N	N	N	N

NO. Category	Estimated Concentration (µg/ℓ)	Discharge Severit (Estimated Conc./ DMEG Conc.) Health	Discharge Severit Ecological	Basis for DMEG Value Health	Basis for DMEG Value Ecological
33. Magnesium	2,437	3E-2	3E-2	a	e
71. Manganese	716	3E0	7E0	c	c
13. Mercury	N.R.				
69. Molybdenum	<4	<5E-5	<6E-4	a	e
76. Nickel	<5	<2E-2	<5E-1	a	c
29. Potassium	1,100	3.7E-2	2.6E-2	a	a
54. Selenium	N.R.				
79. Silver	<30	<1.2E-1	6E0	c	c
20. Sodium	30,736	N	N	N	N
35. Strontium	39	8E-4	N	g	N
45. Tin	<10	N	N	N	N
62. Titanium	<1	<1E-5	<1E-3	a	c
65. Vanadium	<5	<2E-3	3E-2	a	e
61. Yttrium	<1	N	N	N	N
81. Zinc	<2	<8E-5	<2E-2	c	c
SSMS DATA					
Palladium	<1	N	N	N	N
48. Phosphate	40	N	N	a	c
77. Platinum	<1	N	N	N	N
14. Praseodymium	<1	N	N	N	N
Rhenium	<1	N	N	N	N
75. Rhodium	<1	N	N	N	N
30. Rubidium	<1	N	N	N	N
73. Ruthenium	<1	N	N	N	N
84. Samarium	<1	N	N	N	N
60. Scandium	<2	<3E-6	N	g	N
54. Selenium	6	1E-1	2E-1	c	c
43. Silicon	730	N	N	N	N
53. Sulfur	>6,000	N	N	N	N
67. Tantalum	<1	N	N	N	N
55. Tellurium	<1	<7E-4	N	a	N
Terbium	<1	N	N	N	N
41. Thallium	<1	<7E-4	N	a	N
85. Thorium	<10	<1.7E-4	<2.0E-2	h	c
Thulium	<1	N	N	N	N
70. Tungsten	<1	<7E-5	N	a	N
85. Uranium	<10	<2E-4	<2E-2	h	c
Ytterbium	<1	N	N	N	N
63. Zirconium	<30	N	N	N	N
Total Discharge Severity =		4E0	2E1		

a = TLV
b = TLM, lowest
c = most stringent criteria
d = carcinogenity
e = LC_{50}
f = NIOSH recommendation
g = LD_{50}
h = regulations for protection against radiation
i = lowest concentration reported to produce effects in vegetation
N = DMEG value is not available

Tables 5-57 through 5-60 list the proximate and ultimate analyses for the run-of-mine coal, clean coal, fine refuse, and the coarse refuse, respectively. As expected, the clean coal has a 15 percent lower sulfur content and 10 percent greater energy content. On a lb $SO_2/10^6$ Btu basis, the clean coal has an equivalent emission of 5.70 vs. 7.30 for ROM coal, a 22 percent reduction.

The results of the water quality analyses performed on water from the three settling ponds are compared to the most stringent state effluent water regulations for eastern and midwestern states as stated in the Bureau of National Affairs, Environment Reporter State Water Laws.(34) These comparisons, shown in Table 5-61, identified that all water quality parameters for each of these waste streams met the most stringent state effluent regulations.

For those waste streams that could potentially enter the ground water (i.e., runoff flows and solids leachates), the applicable water quality parameters were compared to the Extraction Procedure Toxicity Concentrations of the Resource Conservation and Recovery Act (RCRA).(35) These EP Toxicity Concentrations are the determining criteria for classifying wastes as hazardous or nonhazardous.

Table 5-62 shows that the concentrations of all constituents in the applicable waste streams are well below the levels specified by the RCRA Extraction Procedure Toxicity Concentrations. However, note that the leachate samples were generated according to the ASTM Proposed Method for Leaching of Waste Materials, and not the extraction procedure stated in the May 19, 1980 Federal Register, 40 CFR 261; 45 FR 33119. The major difference between the procedures is that the ASTM method does not require the sample to be maintained at a pH level of 5.0 ± 0.2. In fact, the pH is not monitored. A pH level of 5.0 ± 0.2 may increase the amount of elements leached from the solid sample. Therefore, the constituent concentrations listed on Table 5-62 might have been greater if the extraction procedure identified in the May 19, 1980 Federal Register was used.

Table 5-63 shows the results of particulate morphology analyses.

TABLE 5-57. PROXIMATE AND ULTIMATE ANALYSES OF ROM COAL

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture	2.72	xxxxx
% Ash	22.16	22.78
% Volatile	34.14	35.09
% Fixed Carbon	40.98	42.13
Total	100.00	100.00
Btu/lb	10,764	11,065
% Sulfur	3.93	4.04

	% Weight	
ULTIMATE ANALYSIS	As Received	Dry Basis
Moisture	2.72	xxxxx
Carbon	59.50	61.16
Hydrogen	4.09	4.20
Nitrogen	1.48	1.52
Chlorine	0.13	0.13
Sulfur	3.93	4.04
Ash	22.16	22.78
Oxygen (diff)	5.99	6.17
	100.00	100.00

TABLE 5-58. PROXIMATE AND ULTIMATE ANALYSES OF CLEAN COAL

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture	6.15	xxxxx
% Ash	12.70	13.53
% Volatile	37.21	39.65
% Fixed Carbon	43.94	46.82
Total	100.00	100.00
Btu/lb	11,808	12,582
% Sulfur	3.36	3.58

	% Weight	
ULTIMATE ANALYSIS	As Received	Dry Basis
Moisture	6.15	xxxxx
Carbon	64.82	69.07
Hydrogen	4.35	4.63
Nitrogen	1.48	1.58
Chlorine	0.11	0.12
Sulfur	3.36	3.58
Ash	12.70	13.53
Oxygen (diff)	7.03	7.49
	100.00	100.00

TABLE 5-59. PROXIMATE AND ULTIMATE ANALYSES OF FINE REFUSE

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture	35.13	xxxxx
% Ash	24.54	37.82
% Volatile	17.49	26.96
% Fixed Carbon	22.84	35.22
Total	100.00	100.00
Btu/lb	5,706	8,795
% Sulfur	1.59	2.45

	% Weight	
ULTIMATE ANALYSIS	As Received	Dry Basis
Moisture	35.13	xxxxx
Carbon	32.23	49.68
Hydrogen	2.13	3.28
Nitrogen	0.71	1.09
Chlorine	0.10	0.16
Sulfur	1.59	2.45
Ash	24.54	37.82
Oxygen (diff)	3.57	5.52
	100.00	100.00

TABLE 5-60. PROXIMATE AND ULTIMATE ANALYSES OF COARSE REFUSE

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture	1.11	xxxxx
% Ash	75.69	76.54
% Volatile	13.66	13.81
% Fixed Carbon	9.54	9.65
Total	100.00	100.00
Btu/lb	2,658	2,688
% Sulfur	9.21	9.31

	% Weight	
ULTIMATE ANALYSIS	As Received	Dry Basis
Moisture	1.11	xxxxx
Carbon	13.55	13.70
Hydrogen	1.24	1.25
Nitrogen	0.40	0.40
Chlorine	0.05	0.05
Sulfur	9.21	9.31
Ash	75.69	76.54
Oxygen (diff)	-1.25	-1.25
	100.00	100.00

TABLE 5-61. SUMMARY AND EVALUATION OF WATER QUALITY PARAMETERS FOR LIQUID STREAMS (mg/ℓ)

Water Quality Parameter	Pondwater #1	Pondwater #2	Pondwater #3	Clean Coal Pile Runoff	ROM Pile Runoff	Coarse Refuse Pile Runoff	Most Stringent State Effluent Regulation (mg/ℓ)	States Having * Most Stringent Regulation
Cl^-	85	65	25	400	200	125	1,500**	WV
F^-	1.2	1.05	0.85	0.77	0.75	0.82	15	IL
$SO_4^=$	400	140	80	2,400	760	750	3,375**	IN
$S^=$	>6	>2	>5	>4	>10	>4	None	
Ammonia - N	1.2	<0.1	<0.1	2.5	0.8	0.4	2.5/4.0***	IL
Nitrite - N	<0.015	<0.01	<0.01	0.01	0.02	0.025	None	
Nitrate - N	0.04	0.05	1.0	26	2.0	2.5	150**	OH
COD	18.7	10.8	12.8	---	---	---	None	
BOD	1.9	2.3	2.3	1.6	4.7	5.0	30	IL, KY

* Based on Northern Appalachian, Eastern, and Midwest Coal Producing States (i.e., IL, IN, KY, MI, MD, OH, PA, and WV)

** Based on Surface Water Quality Standard x 15

*** 2.5 is applicable for April to October; 4.0 is applicable for November to March

TABLE 5-62. ESTIMATED CONCENTRATIONS OF POTENTIAL POLLUTANTS IN PREPARATION PLANT WASTE STREAMS COMPARED TO RCRA EXTRACTION PROCEDURE TOXICITY STANDARDS (mg/ℓ)

	Estimated Concen-tration ROM Coal Leachate	Estimated Concen-tration Clean Coal Leachate	Estimated Concen-tration Coarse Ref. Leachate	Estimated Concen-tration Pond #1 Sediment Leachate	Estimated Concen-tration Pond #2 Sediment Leachate	Estimated Concen-tration Pond #3 Sediment Leachate	Estimated Concen-tration Clean Coal Storage Pile Runoff	Estimated Concen-tration Coarse Refuse Pile Runoff	Estimated Concen-tration ROM Storage Pile Runoff	RCRA EP Toxicity Standards
pH	8.0	8.0	8.4	8.2	8.3	8.0	-	-	-	2.0-12.5
Arsenic	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	≤0.003	≤0.003	≤0.008	5.0
Barium	0.03	0.02	0.03	0.086	0.026	0.026	0.08	0.03	0.05	100.0
Cadmium	-	-	-	-	-	-	-	-	-	1.0
Chromium	0.002	0.002	0.002	0.002	0.002	0.002	0.02	0.014	0.007	5.0
Lead	<0.007	<0.007	<0.007	<0.006	<0.006	<0.008	0.003	≤0.002	≤0.007	5.0
Mercury	-	-	-	-	-	-	0.0002	<0.0002	<0.0002	0.2
Selenium	0.006	0.002	0.03	0.002	0.002	0.006	0.004	≤0.008	-	1.0
Silver	-	-	-	-	-	-	-	-	-	5.0

TABLE 5-63. SUMMARY OF PARTICULATE MORPHOLOGY DATA

	Particulate Size (μ)					
	>7.2	7.2-3	3-1.5	1.5-0.95	0.95-0.49	<0.49
Downwind	80%Q,20%C	Q	Q	Q	Q	50% each
CRSP	75%Q,25%C	85%Q,15%C	Q	Q	Q	75%Q,25%C
CCSP	50% each	Q	50% each	50% each	70%Q,30%C	70%C,30%Q
ROMSP	Q	Q	80%Q,20%C	80%Q,20%C	80%Q,20%C	50% each
Upwind	Q	Q	Q	Q	Q	50% each

Q = Quartz   C = Coal   CRSP = Coarse Refuse Storage Pile
CCSP = Clean Coal Storage Pile   ROMSP = Run-Cf-Mine Storage Pile

Upwind particulates consisted mainly of quartz dust, except the finest fraction, which was contaminated by large coal particles due to filter overloading. Downwind particulates contained slightly more coal than upwind, particularly the finest fraction.

Particulates in the plant site were generally similar to those upwind, except for the marked increase in coal particles near the CCSP and moderate increase of coal particles in the finer fractions near the ROMSP.

Particulate morphology for both quartz and coal was mostly subrounded to subangular and distinct (as opposed to aggregated), with fairly smooth surfaces. This reflects the effects of particle erosion typical of aeolian transport.

SECTION 6.0

QUALITY ASSURANCE AND QUALITY CONTROL

Elements of the Quality Assurance (QA) and Quality Control (QC) program include:

- Documentation of all data collected both by Versar and subcontractors.
- Assessment of data accuracy and representativeness, identification and documentation of discrepancies and uncertainties, and development of resolution plans.
- Sampling and laboratory QA/QC programs.
- Technical and independent review of work by senior professionals and regular management review of all quality control procedures.

Versar's Quality Control Program is coordinated by a Quality Assurance staff for both the analytical laboratory operations and engineering operations. In addition, the Quality Assurance staff provides external quality control by use of on-site system surveys, independent performance audits, inter-laboratory comparisons, and periodic evaluation of analytical and engineering quality control procedures.

The Quality Assurance program is divided into four basic divisions, including: Engineering Analysis Quality Control, Sampling Quality Control, Analytical Chemistry Quality Control, and Report Quality Control. A brief summary of the QC components within the program are presented below.

6.1 ENGINEERING ANALYSIS QUALITY CONTROL PROGRAM

This program includes an information control system which ensures the following:

- All activities are represented in an identifiable form, and all documents are maintained in a centralized record file.
- Engineering worksheets and calculations are verified and sampled.
- The environmental assessment data base has a zero-error computer input.

6.2 SAMPLING QUALITY CONTROL PROGRAM

Versar's Sampling Quality Control Program applies to all portions of the sampling analysis, including:

- Uniformity of sample collection procedures.
- Sample control.
- Equipment control.
- Recordkeeping - detailing procedures carried out and problems encountered in the field.
- Summary reports detailing these activities and problems.

6.3 VERSAR ANALYTICAL LABORATORY QUALITY CONTROL PROGRAM

The Versar Analytical Quality Control Program (VAQCP) is equivalent to the Quality Control Program in daily use at the EPA Region V Control Regional Laboratory. The purpose of the program is to obtain real-time data on the precision, accuracy, and recovery of each analyzed parameter. It ensures accountability, data quality, and traceability and, as a result, validates all results. The program is based on the periodic analysis and interpretation of results of spiked samples and spiked sample duplicators, as well as maintenance, calibrations, and monitoring of the quality of various materials used in the analytical procedures.

The program consists of three basic elements including documentation, instrument calibration, and analysis controls.

6.3.1 Documentation

A batch control number is assigned to each shipment of samples received by Versar for analysis. All work performed on a batch is documented in the following logbooks for purposes cited:

- Sample receiving logbook - to log the samples when they are received and assign a batch number.
- Extraction logbook - to record the sample preparation and analyses done on every batch.
- Instrument logbook - to record the use and maintenance of gas chromatographic detectors, columns, and other instruments.
- Standards logbook - to record the preparation and use of all the standards in the laboratory.
- QC logbook - to record all the day-to-day QC data obtained from the analysis of a batch.
- Chemist's notebook - to record the raw data and final data for every batch.

6.3.2 Instrument Calibration

Prior to analysis of samples, the analytical instrument is calibrated using at least three standards that cover the working range of the method. The standards are equally spaced throughout the operating concentration range. The slope, intercept, and correlation coefficient for each calibration curve are recorded in the QC logbook. The correlation coefficient should be better than 0.995. If not, a new calibration curve is prepared.

Each day, if operation is continuous, or before analyzing each batch of samples if operation is non-continuous, a minimum of two check standards are analyzed to establish the validity of the original calibration curve. Check standards represent the range of the original calibration curve, i.e., one above and one below the mid-point of the calibration curve. If these check standards fall outside the established limits, a new calibration curve is prepared.

6.3.3 Controls

To obtain data on the precision, accuracy, and recovery of each batch of samples, the following control samples are analyzed:

- Reagent blank - to check for laboratory contamination.
- Method standard - to check the accuracy of the method, under optimum conditions, excluding any chemical interference from sample matrix.
- Duplicate sample (i.e., replicates) - to check the laboratory precision and provide a measure for analytical error.
- Spiked sample - to check the recovery of parameter of interest, including any chemical interference from the sample matrix.

In addition to the four control samples, commercial reference standards are also analyzed bi-annually for parameter of interest. The data obtained from these analyses are recorded in the QC logbook.

In summary, the QC logbook contains the following information:

- Precision data from duplicate analyses.
- Accuracy data from method standards.
- Accuracy data from spiked sample analysis.
- Accuracy data from reference standards.
- Check of contamination from reagent blank analysis.
- Detection of limits of the method.
- Recovery from spiked sample analysis.
- Slope, intercept, and correlation coefficient of calibration curve.

6.4 REPORT QUALITY CONTROL

All reports generated at Versar are subjected to four levels of quality control. After completion of the first draft of a report, a review is performed by an independent technical staff member and appropriate revisions are made. Next the report is reviewed by the Program Manager and followed by a review by the staff Editor. Finally all reports are reviewed by the Division Manager or his designee.

6.5 SUBCONTRACTOR QUALITY CONTROL

In addition to facilitating the QC effort of in-house activities, Versar's QA staff interacts with the subcontractor(s) to ensure that their data meets the standards of the Versar QA/QC program and customer requirements. This includes, as required, submission of duplicate samples, and spiked and method standards by Versar to the subcontractor. In cases where the validity of data is in question, Versar's analytical laboratory analyzes duplicate or split samples by alternate, equivalent methods or samples are sent to independent laboratories for analysis.

6.6 QUALITY ASSURANCE AND QUALITY CONTROL: LEVEL 1 ENVIRONMENTAL ASSESSMENT

A program of suitable laboratory techniques, quality control, and quality assurance is required for Level 1 Assessments. Versar's QA/QC program meets or exceeds the requirements specified in the "Procedures Manual for Level 1 Environmental Assessment."

As specified in the "Procedures Manual for Level 1 Environmental Assessment," the goal of the Level 1 sampling and analysis program is to acquire environmental assessment data having an accuracy factor of 3. (34) Generally nothing is known about the composition of samples of this type. As a result, the analyst may not recognize artificial results except by comparison to analytical controls or does not know what precautions to take to maintain sample integrity. In addition, since Level 1 Environmental assessment samples are not taken in duplicate and generally cannot be split into aliquots without changing the effective limits of detection, the analyst must obtain all information with one sample. As a result, the usual statistical approaches to obtain precision (replicate analysis) and accuracy (independently verified true values) cannot be rigorously applied. Thus, precision and accuracy will normally be dependent on calibration standards. Analysts typically aimed for precision, expressed as a coefficient of variation, of about ten percent for each quantitative operation.

All of Versar's in-house sampling and analysis efforts were carried out according to specifications and protocols outlined in this report. Additional QA/QC efforts were necessary based on results of the initial quality control results from the subcontractor for spark source elemental analysis of liquid samples. Consistent with the above discussion, Versar's analytical laboratories analyzed split liquid samples using an inductively coupled plasma optical emission spectrometer for metal analysis. The results from both methods are provided in Appendices A and B.

Because of the specialized nature of the bioassay techniques, an assessment of selected protocols used by the biological subcontractor were made by external consultants and found to meet the requirements of Level 1.

SECTION 7.0

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations, by sample media, from the Source Test and Evaluation of coal preparation plant No. 1 are presented in this section. A summary of the multimedia chemical and biological stream characteristics and control strategy recommendations are provided in Table 1-1.

7.1 FUGITIVE EMISSIONS

The fugitive particulate samples showed relatively high total ambient concentrations and low Total Discharge Severity. Ambient TSP values were highest around the coal piles, because of the continual coal handling activities in those areas. When the high ambient air TSP value (i.e., upwind value) was subtracted from the downwind results, the contribution to the ambient air 500 m downwind from the preparation plant can be estimated at 175 $\mu g/m^3$. Although 500 m downwind is still within the plant boundary, the 175 $\mu g/m^3$ can be compared to the 24-hour primary and secondary ambient air quality standards for TSP of 260 $\mu g/m^3$ and 150 $\mu g/m^3$, respectively. In contrast, no fugitive particulate sample had a total discharge severity value greater than 0.01.

The TCO + Grav analyses of fugitive vapors were determined to be low after subtracting out the upwind contribution. In fact, three of the four TCO + Grav samples were less than the upwind value. It can be concluded that the preparation plant and specific coal and refuse piles contribute little or no organic gas to the environment. The TDS value for inorganic vapors ranged from 8 - 70 based on health criteria and 0.2 - 2 for ecological criteria. Chromium and nickel were generally the only elements with a DS greater than one. However, for four of the nickel concentrations, the DS value can be attributed to a high nickel value in the XAD-2 resin blank.

The bioassay results for all fugitive source samples were negative.

As shown in Table 5-63, the high downwind TSP loading combined with the particulate morphology results indicated that dust in the plant area was being transported downwind. Better dust control/suppression techniques would minimize much of the downwind TSP contribution.

Based upon the results from Plant No. 1 there does not appear to be a fugitive dust problem at the plant boundaries. These results, despite the fact that no dust suppression techniques were used at the plant except for watering dirt roads. An antifreeze was sprayed onto the clean coal during cold weather to aid in handling.

The only constituent found in the vapor was chromium. This is probably related to the nickel contamination problem, since chromium and nickel are often used together in metal alloys. One does not expect chromium to exist as a vapor, since only mechanical processes are used at the preparation plant. A second explanation is that particles less than 0.45 microns were adsorbed by the resin after passing through the filters. Further level 1 environmental assessment efforts should clarify whether the chromium value is a sampling and analysis artifact or is present as a very fine particulate.

The results do not support the need for further study during the level 2 environmental assessment phase.

7.2 LIQUIDS

7.2.1 Fine Waste Slurry Filtrate

This liquid stream was generated by filtering the fine waste refuse slurry. It had a low, but potentially harmful health-based TDS of 11 and a higher ecological-based TDS of 170. Considering that the waste stream contained fine coal particles before filtration, the organics concentration of 700 μg/ℓ is surprisingly low.

7.2.2 Plant Feedwater

Plant feedwater was obtained from the tertiary pond (i.e., pond No. 3). Trace elements were at low concentrations, based on health effects, with no element having DS greater than 1. There were also no detectable chromatographable organics. Gravimetrically determined extractable organics were measured at 700 μg/ℓ. Bioassay tests using Ames and CHO clonal assays showed a low potential for hazardous health-related effects.

7.2.3 Pond Waters

According to the SAM/1A evaluation for inorganic constituents, trace elements were at low concentrations based on health effects (i.e., TDS = 1-2). However, there was a relatively higher potential for hazardous effects on an ecological basis (i.e., TDS = 110-130). The major contributors to the unfiltered pond water TDS (ecological basis) were ammonia, cadmium, and silver.

Individual biological tests for health-related responses were negative (i.e., low hazard potential) for the Ames assay, but moderate effects were indicated for each CHO clonal assay. The EC_{50} values were 63,79, and 126 μℓ/mℓ for ponds No. 1, 2, and 3, respectively; as compared to a low effect value of >600 μℓ/mℓ. The composited pond water aquatic bioassay results showed low or nondetectable effects for fish and invertebrates, but moderate effects on algae. The EC_{50} value, expressed as percent concentration of pond water, was 63.0, 57.0, and 11.5 percent for 12-, 17-, and 21-day exposure periods, respectively.

The total extractable organic concentrations for the pond waters ranged from 500-1,000 μg/ℓ. No chromatographable organics were detected in any pond water sample. That is, the organic concentrations are due entirely to gravimetrically determined organics or other extractable compounds.

When compared to the most stringent state effluent regulations for states in the Eastern Midwest and Northern Appalachian coal regions, the pond waters complied with every regulation. Note that the pond waters at this plant are not discharged, but potentially could be.

7.2.4 Runoff from Coal Piles and Coarse Refuse

Similar to the pond waters, the inorganic constituent SAM/1A evaluation showed low potential hazards for health-based criteria (i.e., TDS = 2-11) and relatively higher potential for ecological-based DS values (i.e., TDS = 80-230). The major inorganic and trace element compounds contributing to the ecological-based TDS were ammonia, manganese, nickel, silver, and cadmium.

The health-related biological assessments, consistent with the inorganic analysis, showed negative results for the Ames assay and nontoxic effects for the CHO clonal assay.

The TCO + Grav results, which ranged from 3,300 μg/ℓ for ROM coal pile runoff to 600 μg/ℓ for clean coal runoff, showed no detectable chromatographable organics. The decrease in extractable organics from the ROM coal pile runoff to the clean coal pile runoff is therefore rather striking.

The water quality parameters in all three runoff samples complied with the most stringent state effluent regulations studied (Table 5-61). Also, the water quality parameters applicable to RCRA EP Toxicity concentrations were well below the maximum allowable concentrations (Table 5-62).

7.2.5 Summary and Recommendations

The results show ammonia having a discharge severity value greater than one, on either a health or ecological basis in all liquid waste streams. It is recommended that the protocol for analyzing ammonia be changed to include the use of standards (to verify results) to determine if the ammonia is a result of interference during analysis or if the origin of the ammonia is from coal mining activities.

The presence of aluminum, cadmium, nickel, and silver in the liquid waste streams is not unexpected. These metals are found in the coal and are not produced by preparation. Cadmium and silver are found in the feedwater, the fine waste slurry filtrate, and in all three pond waters in concentrations of the same magnitude. Because this preparation plant operates a closed cycle system with the plant feedwater coming from pond No. 3, it appears that the cadmium and silver are being recirculated. These results support the need for further characterization during the level 2 environmental assessment phase.

7.3 SOLIDS AND LEACHATE WASTE STREAMS

7.3.1 Fine Refuse Waste Solids

The TDS values were 560 and 10,040 based on health and ecological criteria, respectively. Major contributors to the health TDS were Cr, Mn, Ba, Be, Cd, Li, Se, and V. For the ecological TDS, Mg, and Cd were the major contributors.

The health-related bioassay tests (i.e., Ames, RAM, and Rodent Acute Toxicity) showed low or nondetectable effects on the fine refuse slurry. The ecological-related aquatic bioassays, however, showed moderate effects on invertebrates, with an EC_{50} value for 48 hours of 74.5 percent, and moderate effects on algae, resulting in EC_{50} values of 64.0, 60.0, and 21.0 percent for 12-, 17-, and 21-day exposure periods, respectively. The fish biological assessment resulted in low or nondetectable effects from the slurry.

7.3.2 Coarse Refuse and Coarse Refuse Leachate

The health-based TDS for coarse refuse was 700, with Cr, Mn, As, Ba, Be, Pb, Li, P, Se, and V being major contributors. The ecological-based TDS was higher at 10,030; however, only phosphorus was a major contributor to this value.

The Ames assay for coarse refuse was negative, but the RAM assay produced moderate effects and was characterized by an EC_{50} of 112 μℓ/mℓ.

In contrast to the refuse itself, the coarse refuse leachate had a health-based TDS of 3 and an ecological-based TDS of 40. No single element had a DS greater than 1 for the health-based TDS, while ammonia, cadmium, nickel, and silver contributed to the ecological TDS.

The extractable, organic material was below detection limits for the leachate.

The health-related bioassay tests on the leachate showed low or nondetectable effects (i.e., Ames and CHO clonal assays). The ecological-related bioassay was conducted on a leachate composite and is presented separately.

All applicable water quality parameters are significantly below the RCRA EP Toxicity Concentrations in the coarse leachate sample (Table 5-62).

7.3.3 ROM Coal and ROM Coal Leachate

In contrast to the moderate effect found for coarse refuse, the biological test results on ROM coal showed low or nondetectable effects. The Ames assay also showed nondetectable effects.

Quite similar to the coarse refuse leachate, the health-based TDS for ROM coal leachate is low, about 1. The ecological-based TDS is higher at 30 with ammonia, cadmium, and silver having DS values greater than one. The extractable organics concentration in the leachate was measured at 1,500 μg/ℓ. The value was due primarily to gravimetrically determined constituents.

Health-related bioassays on the leachate revealed low or nondetectable effects for the Ames and CHO clonal assays. The ecological-related bioassays are presented separately, because coal and coarse refuse leachates were composited for that test.

In the ROM coal leachate sample, the water quality tests showed that all applicable water quality parameters are significantly below the RCRA EP Toxicity Concentrations (Table 5-62).

7.3.4 Clean Coal and Clean Coal Leachate

The Ames and RAM assays on the clean coal showed low or nondetectable effects.

As with the leachates discussed above, the clean coal leachate health-based TDS for inorganics was small (i.e., TDS = 3), while the ecological-based TDS was an order of magnitude higher (i.e., TDS = 30). Again, ammonia, cadmium, and silver along with manganese, nickel, and zinc have DS values greater than one. Similar to the coarse refuse leachate, the extractable, organic materials concentration was below detection limits.

The clean coal leachate health-related bioassays (i.e., Ames and CHO clonal) showed no biological responses. The ecological-related bioassay results are discussed below.

All applicable water quality parameters are significantly below the RCRA EP Toxicity Concentrations (Table 5-62).

7.3.5 ROM Coal Leachate, Clean Coal Leachate, and Coarse Refuse Leachate Composite

The leachates from coal and coarse refuse materials were composited for the aquatic biological assessments. The composite produced low or nondetectable effects on the fish and invertebrates. For algae, however, a moderate response was detected. The leachate composite produced EC_{50} values of 23.0, 11.0, and 15.5 percent for 12-, 17-, and 21-day exposure periods, respectively.

7.3.6 Ponds No. 1, 2, and 3 Sediment and Sediment Leachates

The health-based TDS values were 2,450, 550, and 800 for sediments from ponds No. 1, 2, and 3, respectively. The major contributors for pond No. 1 were Sr, Cr, and Mn; for Pond No. 2--Ba and Mn; for pond No. 3--Mn. The ecological-based TDS values were 10,000 for pond No. 1 and 3,100 for ponds No. 2 and 3. In all cases the major contributor was phosphorus with a much smaller contribution from Mn.

The extractable organic concentrations in the sediment were 864, 199, and 85 mg/g for ponds No. 1, 2, and 3, respectively. The decreasing nature of these results characterize the reduced percentage of fine coals in the sediment for the primary, secondary, and tertiary ponds.

The health-related biological assessment results were negative for the Ames assays (individual sediment samples) and low or nondetectable effects for the RAM assay (sediment composite).

The sediment leachate results followed a similar pattern to the sediment results. As in the sediments, the health-based TDS results for inorganics in sediment leachates (values of 2, 2, and 4) were lower than the corresponding ecological-based TDS results (20, 15, and 20) by an order of magnitude. Again, ammonia added significantly to the ecological-based total discharge severity values.

The total extractable organics results from the leachates also reflected reduced concentrations of coal in the secondary and tertiary sedimentation ponds. The pond sediment leachate from ponds No. 2 and 3 were at or below the detection limit of 1,000 μg/ℓ. Pond No. 1 had a TCO + Grav value of 2,300 μg/ℓ, of which 200 μg/ℓ were chromatographable organics.

Health-based bioassays showed low or nondetectable responses for Ames assays (individual leachate samples) and for the CHO clonal assay (leachate composite sample). The aquatic bioassay of the leachate composite resulted in low or nondetectable effects on fish and invertebrates, and moderate effects on algae. The EC_{50} values for the algae test were 10.5, 13.5, and 10.5 percent for 12-, 17-, and 21-day exposure periods, respectively.

All pond sediment leachates complied with the RCRA EP Toxicity Concentrations (Table 5-62).

7.3.7 Summary and Recommendations

As expected, the pond sediments and fine waste solids had many heavy metals and other elements with discharge severities greater than one and as high at 10,000. These elements originate in the coal and the cleaning process is intended to produce refuse by removing incombustibles from the coal. None of the elements are changed drastically from their natural state because only mechanical processes are used in the cleaning process. The high concentrations of the elements in the refuse solids does emphasize the concern over ultimate disposal of those wastes and that actions must be taken to avoid the migration of these chemicals to the environment.

Leaching of the elements from the solids and into the groundwater is an obvious pathway for migration. The leachates from the ROM coal, clean coal, and coarse refuse have considerably smaller potentials for problems based on ecological effects and little or no problem from the health standpoint. It appears that the coal and coarse refuse leachate tests should have relatively low priority during the level 2 environmental assessment phase.

In contrast, the pond sediment leachates showed a higher potential for problems based on ecological DMEG values and bioassays. Interestingly, the sediment leachate chemical concentrations are much higher than the pond waters which are also in contact with the sediment. This is undoubtedly due to the dilution of pond water by plant influent and rain. Note that the ratio of leachate water to sediments is only 4:1 on a weight basis. Another reason for the concentration difference is that the pH of the ponds is in the 7-8 range. In that pH range, trace elements typically have lower solubilities. It is recommended that the EP Method for testing leachability, described in the RCRA regulations, be used in future level 1 and 2 environmental assessments to investigate the leaching potential under acidic (i.e., worst case) conditions.

Since the heavy metals and trace elements appear in greatest concentrations in the pond sediments and are susceptible to leaching, it is recommended that a better characterization of pond sediments be made during level 2 testing. The characterization should involve obtaining samples from different sections of the pond and testing sediments at different depths to determine the potential for pollutant migration downward and into the groundwater. Wells upgradient and downgradient of the ponds should also be monitored.

7.4 EXTRACTABLE ORGANIC RESULTS

TCO + Grav analytical results are shown on Table 7-1. For liquid media, the values ranged from 800-3,500 μg/ℓ. In fact, the TCO value was equal to or less than detectable limits for every liquid sample. That is, all the organic concentrations in these liquids would appear to be non-chromatographable. Another explanation for the relatively high gravimetric (i.e., non-volatile) values is that some inorganic ions do interfere with gravimetric analyses, and this may explain some or all of the measured gravimetric results for liquid samples.

The pond sediment values are consistent with expected results. The high organic concentration in pond No. 1 sediment is derived from fine coal mixed

TABLE 7-1.

TCO + GRAV Analysis Results

Descriptive Sample	TCO mg	GPAV mg	TCO + GRAV total mg	Concentration mg/m^3; mg/g; mg/ℓ
XAD-2 Resins Soxhlet				
Clean Coal Pile Fug.	4	7	11	0.14 mg/m^3
Coarse Refuse Pile Fug.	1	2	3	0.05 mg/m^3
ROM Coal Pile Fug.	7	11	18	0.24 mg/m^3
Upwind Fug.	14	4	18	0.17 mg/m^3
Downwind Fug.	3	2	5	0.05 mg/m^3
Blank	0.1	<1.8	0.1	<0.02 mg/m^3
Pond Sediment				
#1	14	113	127	864 mg/g
#2	5	26	31	199 mg/g
#3	4	8	12	85 mg/g
Pond Sediment Leachate				
#1	2	16	18	2.3 mg/ℓ
#2	<1	<8	ND	<1 mg/ℓ
#3	<1	8	8	1 mg/ℓ
Coal Leachate				
Clean Coal	<2	<4	ND	<1 mg/ℓ
ROM Coal	2	4	6	1.5 mg/ℓ
Coarse Refuse	<2	<4	ND	<1 mg/ℓ
Field Extracts				
Fine Waste Slurry Filtrate	<1	9	9	0.9 mg/ℓ
Pond #1 Filtrate	<1	8	8	0.8 mg/ℓ
Pond #2 Filtrate	<1	7	7	0.7 mg/ℓ
Pond #3 Filtrate	<1	12	12	1.2 mg/ℓ
Clean Coal Pile Runoff	<1	2	2	0.8 mg/ℓ
Coarse Coal Pile Runoff	<1	11	11	2.2 mg/ℓ
ROM Coal Pile Runoff	<1	14	14	3.5 mg/ℓ
Spike - 18	<1*(0.6)	13	13	1.3 mg/ℓ
Blank - 18	<1	2	2	0.2 mg/ℓ

* Value for spike

in with the fine refuse. The decline of organic concentrations from pond No. 1 to pond No. 2 to pond No. 3 reflects the settling (i.e., control) process in the ponds. The 90 percent reduction in organic (i.e., coal) constituents in the sediment indicates the sedimentation control process is operating successfully.

XAD-2 resin organic concentrations are high when compared to the ambient air quality standard for hydrocarbons of 160 $\mu g/m^3$. Interestingly, the highest TCO value measured is for the upwind sample, indicating that the major source of hydrocarbons is probably not the preparation plant. The only TCO + Grav value greater than the upwind concentration is downwind (200 m) from the Kentucky No. 9 ROM coal pile. Since the Kentucky No. 9 coal is delivered by diesel truck and there is constant vehicular activity in that area, one may attribute the high organic reading to the diesel emissions.

The low total organic concentrations in most streams is not surprising since coal preparation is a physical process which does not burn or treat the coal in any manner, except for crushing and washing. No organic solvents or similar materials are used to clean the coal. Since organic material is unlikely to be leached from the coal by washing, the results presented above are consistent with expectations, and no organics controls are needed.

REFERENCES

1. U.S. Department of Health, Education and Welfare. Environmental Health Series. *Workbook of Atmospheric Dispersion Estimates*. 1970. pp. 3-10.

2. APHA-AWWA-WPCF. *Standard Methods for the Examination of Water and Wastewater*. 14th Edition. 1975. pp. 550-554.

3. *IBID.*, pp. 543-550.

4. Kopp, J.F., and G.D. McKee. *EPA Methods for Chemical Analysis of Water and Wastewater*. EPA-600/4-79-020, U.S. Environmental Protection Agency, Cincinnati, Ohio, March 1979. pp. 460.

5. *IBID.* ,p. 120.

6. *Op. Cit.* , Ref. 2 , pp. 202-206.

7. *Op. Cit.* , Ref. 4 , p. 310.

8. *IBID.* ,p. 305

9. *IBID.* ,p. 350.

10. *IBID.* ,p. 353.

11. *IBID.* ,p. 365.

12. *IBID.* ,p. 376.

13. *IBID.* ,p. 375.

14. *Op. Cit.* , Ref. 2 , pp. 391-393.

15. *Op. Cit.* , Ref. 4 , p. 325.

16. *Op. Cit.* , Ref. 2 , pp. 96-98

17. American Society for Testing Materials. *Annual Book of ASTM Standards*. Part 31. 1979. pp. 1258-1261.

18. Lentzen, D.E., D.E. Wagoner, E.D. Estes, and W.F. Gutknecht. *IERL-RTP Procedures Manual: Level 1 Environmental Assessment* (Second Edition). EPA-600/7-78-201, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, October 1978. p. F-1.

REFERENCES
(continued)

19. Op. Cit., Ref. 4.

20. Op. Cit., Ref. 18, pp. 140-144.

21. Duke, K.M., M.E. Davis, and A.J. Dennis. IERL-RTP Procedures Manual: Level 1 Environmental Assessment, Biological Tests for Pilot Studies. EPA-600/7-77-043, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, April 1977. p. 105.

22. Ames, B.N., J. McCann, and E. Yamaski. Methods for Detecting Carcinogens and Mutagens with the Salmonella/Mammalian - Microsome Mutagenicity Test. Mutation Research 31:347-364, 1975.

23. Op. Cit., Ref. 21.

24. Winniger, M.T., F.A. Kulik, and W.D. Ross. Clonal Cytotoxicity Assay Using Chinese Hamster Ovary Cells (CHO-K1) For Testing Environmental Chemicals. In Vitro 14:381, 1978.

25. Op. Cit., Ref. 21.

26. Op. Cit., Ref. 21.

27. Gardner, D.E., J.A. Graham, and F.J. Miller. Technique for Differentiating Particles that are Cell-Associated or Ingested by Macrophages. Applied Microbiology 25:471-475.

28. Op. Cit., Ref. 21.

29. Op. Cit., Ref. 21.

30. Op. Cit., Ref 2.

31. Op. Cit., Ref. 21.

32. Stephen, C.E. Computer Program for Calculation of LC_{50} values. U.S. Environmental Protection Agency, Environmental Research Laboratories, Duluth, Minnesota. 1978.

33. Cleland, J.G., and G.L. Kingsbury. Multimedia Environmental Goals for Environmental Assessment, Volume II: MEG Charts and Background Information. EPA-600/7-77-1366, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, November 1977. p. 449.

34. Bureau of National Affairs. Environment Reporter, State Water Laws.

35. Federal Register. May 19, 1980, Volume 45-No. 98.

APPENDIX A

SPARK SOURCE MASS SPECTROMETER DATA

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 01-01 A 10/10

Clean Coal

IAD No.: 97-D398-377-22

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	3	Terbium		Ruthenium		Vanadium	400
Thorium	4	Gadolinium		Molybdenum	19	Titanium	MC
Bismuth		Europium	≤0.3	Niobium	4	Scandium	1
Lead	10	Samarium	2	Zirconium	27	Calcium	MC
Thallium	1	Neodymium	2	Yttrium	7	Potassium	MC
Mercury	NR	Praseodymium	1	Strontium	34	Chlorine	960
Gold		Cerium	28	Rubidium	18	Sulfur	MC
Platinum		Lanthanum	22	Bromine	8	Phosphorus	160
Iridium		Barium	* 230	Selenium	26	Silicon	MC
Osmium		Cesium	1	Arsenic	30	Aluminum	>210
Rhenium		Iodine	1	Germanium	5	Magnesium	MC
Tungsten		Tellurium	0.3	Gallium	7	Sodium	>540
Tantalum		Antimony	1	Zinc	35	Fluorine	* ≈330
Hafnium		Tin	0.5	Copper	23	Oxygen	NR
Lutecium		Indium	STD	Nickel	9	Nitrogen	NR
Ytterbium		Cadmium	0.4	Cobalt	4	Carbon	NR
Thulium		Silver		Iron	MC	Boron	50
Erbium		Palladium		Manganese	240	Beryllium	2
Holmium		Rhodium		Chromium	24	Lithium	12
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.2 ppm
MC — Major Component
INT — Interference

Approved:

Date: November 28, 1979

Analyst: J. Oldham

Sample No.: 03-01 10/11

IAD No.: 97-D398-377-22

Waste Slurry Solids

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	1	Terbium		Ruthenium		Vanadium	110
Thorium	3	Gadolinium	0.4	Molybdenum	4	Titanium	MC
Bismuth		Europium	0.4	Niobium	8	Scandium	4
Lead	3	Samarium	1	Zirconium	43	Calcium	MC
Thallium		Neodymium	7	Yttrium	12	Potassium	MC
Mercury	NR	Praseodymium	3	Strontium	60	Chlorine	85
Gold		Cerium	22	Rubidium	130	Sulfur	>930
Platinum		Lanthanum	16	Bromine	1	Phosphorus	MC
Iridium		Barium	360	Selenium	2	Silicon	MC
Osmium		Cesium	2	Arsenic	3	Aluminum	>150
Rhenium		Iodine	0.7	Germanium	3	Magnesium	MC
Tungsten		Tellurium	0.3	Gallium	12	Sodium	>380
Tantalum		Antimony	0.9	Zinc	10	Fluorine	≃230
Hafnium		Tin	0.5	Copper	9	Oxygen	NR
Lutecium		Indium	STD	Nickel	3	Nitrogen	NR
Ytterbium		Cadmium	3	Cobalt	3	Carbon	NR
Thulium		Silver		Iron	MC	Boron	110
Erbium		Palladium		Manganese	76	Beryllium	3
Holmium		Rhodium		Chromium	76	Lithium	21
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: ML Jacobs

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 04-01 10/11

IAD No.: 97-0398-377-22

Fine Waste Slurry Filtrate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.007	Terbium		Ruthenium		Vanadium	0.002
Thorium	≤0.008	Gadolinium		Molybdenum	0.03	Titanium	1
Bismuth		Europium		Niobium	≤0.001	Scandium	≤0.001
Lead	≤0.004	Samarium		Zirconium		Calcium	130
Thallium		Neodymium		Yttrium	≤0.003	Potassium	>12
Mercury		Praseodymium		Strontium	0.2	Chlorine	>110
Gold		Cerium		Rubidium	0.007	Sulfur	>6
Platinum		Lanthanum		Bromine	0.2	Phosphorus	0.02
Iridium		Barium	0.03	Selenium	0.01	Silicon	0.7
Osmium		Cesium		Arsenic	≤0.004	Aluminum	0.1
Rhenium		Iodine	0.01	Germanium	<0.001	Magnesium	4
Tungsten		Tellurium		Gallium	0.001	Sodium	>2
Tantalum		Antimony		Zinc	0.01	Fluorine	≈1
Hafnium		Tin		Copper	0.001	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.02	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.001	Carbon	NR
Thulium		Silver		Iron	0.06	Boron	0.02
Erbium		Palladium		Manganese	0.02	Beryllium	
Holmium		Rhodium		Chromium	0.002	Lithium	0.006
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: MLJacobs

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 05-01 A 10/08

IAD No.: 97-D398-377-22

ROM Coal

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	3	Terbium	≤0.1	Ruthenium		Vanadium	76
Thorium	4	Gadolinium	0.5	Molybdenum	5	Titanium	MC
Bismuth		Europium	0.3	Niobium	12	Scandium	6
Lead	8	Samarium	2	Zirconium	* 52	Calcium	MC
Thallium		Neodymium	3	Yttrium	13	Potassium	MC
Mercury	NR	Praseodymium	2	Strontium	41	Chlorine	460
Gold		Cerium	24	Rubidium	88	Sulfur	>630
Platinum		Lanthanum	11	Bromine	9	Phosphorus	170
Iridium		Barium	* 430	Selenium	3	Silicon	MC
Osmium		Cesium	1	Arsenic	9	Aluminum	>100
Rhenium		Iodine	0.5	Germanium	2	Magnesium	MC
Tungsten		Tellurium	0.2	Gallium	13	Sodium	>260
Tantalum		Antimony	0.8	Zinc	17	Fluorine	MC
Hafnium	0.6	Tin	* 2	Copper	14	Oxygen	NR
Lutecium		Indium	STD	Nickel	4	Nitrogen	NR
Ytterbium		Cadmium	0.3	Cobalt	2	Carbon	NR
Thulium		Silver		Iron	MC	Boron	38
Erbium		Palladium		Manganese	41	Beryllium	2
Holmium		Rhodium		Chromium	52	Lithium	6
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: ML Jacobs

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 06-01 A 10/08 **IAD No.:** 97-D398-377-22

Coarse Refuse CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	2	Terbium	0.2	Ruthenium		Vanadium	85
Thorium	5	Gadolinium	1	Molybdenum	2	Titanium	MC
Bismuth	<0.1	Europium	0.7	Niobium	10	Scandium	3
Lead	36	Samarium	4	Zirconium	73	Calcium	MC
Thallium	2	Neodymium	20	Yttrium	7	Potassium	MC
Mercury	NR	Praseodymium	10	Strontium	32	Chlorine	>110
Gold		Cerium	58	Rubidium	39	Sulfur	>280
Platinum		Lanthanum	21	Bromine	9	Phosphorus	MC
Iridium		Barium	480	Selenium	6	Silicon	MC
Osmium		Cesium	<0.1	Arsenic	9	Aluminum	>45
Rhenium		Iodine	0.2	Germanium	0.8	Magnesium	MC
Tungsten	0.4	Tellurium	0.1	Gallium	33	Sodium	>110
Tantalum	≤0.4	Antimony	0.9	Zinc	30	Fluorine	≈400
Hafnium	3	Tin	1	Copper	15	Oxygen	NR
Lutecium	<0.1	Indium	STD	Nickel	4	Nitrogen	NR
Ytterbium	0.5	Cadmium	0.8	Cobalt	3	Carbon	NR
Thulium	<0.1	Silver		Iron	MC	Boron	17
Erbium	0.2	Palladium		Manganese	150	Beryllium	0.6
Holmium	0.5	Rhodium		Chromium	51	Lithium	16
Dysprosium	0.9					Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: MLJacobs cmw

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 07-01 10/10

IAD No.: 97-D398-377-22

Pond No. 1 Sediment

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	15	Terbium	0.8	Ruthenium		Vanadium	64
Thorium	36	Gadolinium	5	Molybdenum	5	Titanium	MC
Bismuth		Europium	1	Niobium	24	Scandium	5
Lead	35	Samarium	18	Zirconium	120	Calcium	MC
Thallium	2	Neodymium	21	Yttrium	62	Potassium	MC
Mercury	NR	Praseodymium	25	Strontium	140	Chlorine	110
Gold		Cerium	250	Rubidium	41	Sulfur	MC
Platinum		Lanthanum	200	Bromine	7	Phosphorus	MC
Iridium		Barium	510	Selenium	6	Silicon	MC
Osmium		Cesium	7	Arsenic	18	Aluminum	>190
Rhenium		Iodine	2	Germanium	2	Magnesium	MC
Tungsten	1	Tellurium	0.6	Gallium	63	Sodium	>480
Tantalum		Antimony	0.7	Zinc	* 120	Fluorine	MC
Hafnium	5	Tin	1	Copper	26	Oxygen	NR
Lutecium		Indium	STD	Nickel	8	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	6	Carbon	NR
Thulium		Silver		Iron	MC	Boron	18
Erbium	2	Palladium		Manganese	240	Beryllium	0.3
Holmium	2	Rhodium		Chromium	54	Lithium	27
Dysprosium	4					Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.2 ppm
MC — Major Component
INT — Interference

Approved: ML Jacobs chw

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 08-01 10/10 **IAD No.:** 97-D398-377-22

Pond No. 2 Sediment

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	2	Terbium	0.2	Ruthenium		Vanadium	34
Thorium	5	Gadolinium	1	Molybdenum	1	Titanium	MC
Bismuth		Europium	0.6	Niobium	23	Scandium	7
Lead	8	Samarium	4	Zirconium	MC	Calcium	MC
Thallium	0.2	Neodymium	5	Yttrium	15	Potassium	MC
Mercury	NR	Praseodymium	5	Strontium	72	Chlorine	11
Gold		Cerium	26	Rubidium	40	Sulfur	93
Platinum		Lanthanum	21	Bromine	4	Phosphorus	310
Iridium		Barium	MC	Selenium	1	Silicon	MC
Osmium		Cesium	2	Arsenic	4	Aluminum	>45
Rhenium		Iodine	0.5	Germanium	0.3	Magnesium	MC
Tungsten	0.2	Tellurium	<0.1	Gallium	7	Sodium	>110
Tantalum	≤0.4	Antimony	0.3	Zinc	30	Fluorine	≈160
Hafnium	5	Tin	0.4	Copper	6	Oxygen	NR
Lutecium	<0.1	Indium	STD	Nickel	8	Nitrogen	NR
Ytterbium	0.5	Cadmium	0.3	Cobalt	0.9	Carbon	NR
Thulium	<0.1	Silver		Iron	MC	Boron	4
Erbium	0.2	Palladium		Manganese	150	Beryllium	0.2
Holmium	0.5	Rhodium		Chromium	23	Lithium	3
Dysprosium	0.9					Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: ML Jacobs caw

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 09-01 10/10

IAD No.: 97-D398-377-22

Pond No. 3 Sediment

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	7	Terbium	0.3	Ruthenium		Vanadium	57
Thorium	14	Gadolinium	2	Molybdenum	2	Titanium	MC
Bismuth		Europium	1	Niobium	16	Scandium	4
Lead	14	Samarium	4	Zirconium	490	Calcium	MC
Thallium		Neodymium	8	Yttrium	25	Potassium	MC
Mercury	NR	Praseodymium	3	Strontium	54	Chlorine	17
Gold		Cerium	44	Rubidium	66	Sulfur	52
Platinum		Lanthanum	20	Bromine	7	Phosphorus	330
Iridium		Barium	810	Selenium	0.9	Silicon	MC
Osmium		Cesium	1	Arsenic	7	Aluminum	>76
Rhenium		Iodine	0.9	Germanium	0.4	Magnesium	MC
Tungsten		Tellurium		Gallium	11	Sodium	>190
Tantalum		Antimony	1	Zinc	50	Fluorine	≈120
Hafnium	6	Tin	2	Copper	10	Oxygen	NR
Lutecium	0.4	Indium	STD	Nickel	8	Nitrogen	NR
Ytterbium	2	Cadmium	1	Cobalt	0.1	Carbon	NR
Thulium	0.2	Silver		Iron	MC	Boron	7
Erbium	0.7	Palladium		Manganese	260	Beryllium	0.1
Holmium	0.9	Rhodium		Chromium	35	Lithium	11
Dysprosium	1					Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: MLJacobs cew

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 12-01 10/11

IAD No.: 97-0398-377-22

Feedwater Filtrate CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.007	Terbium		Ruthenium		Vanadium	0.002
Thorium	≤0.008	Gadolinium		Molybdenum	0.01	Titanium	0.3
Bismuth		Europium		Niobium		Scandium	≤0.001
Lead	≤0.003	Samarium		Zirconium	0.006	Calcium	MC
Thallium		Neodymium	≤0.003	Yttrium	0.001	Potassium	4
Mercury	NR	Praseodymium	0.002	Strontium	0.03	Chlorine	2
Gold		Cerium	0.01	Rubidium	0.003	Sulfur	6
Platinum		Lanthanum	0.01	Bromine	0.02	Phosphorus	0.04
Iridium		Barium	0.01	Selenium	0.005	Silicon	3
Osmium		Cesium		Arsenic	<0.001	Aluminum	0.05
Rhenium		Iodine	0.004	Germanium		Magnesium	4
Tungsten		Tellurium		Gallium	0.001	Sodium	>2
Tantalum		Antimony		Zinc	* 0.02	Fluorine	≈0.8
Hafnium		Tin		Copper	0.01	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.02	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver		Iron	0.2	Boron	0.04
Erbium		Palladium		Manganese	0.005	Beryllium	
Holmium		Rhodium		Chromium	0.002	Lithium	0.003
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobs cmw

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 15-01 10/11

IAD No.: 97-D398-377-22

CONCENTRATION IN µg/ml

Pond No. 1 Filtrate

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.008	Terbium		Ruthenium		Vanadium	0.006
Thorium	≤0.008	Gadolinium		Molybdenum	0.02	Titanium	1
Bismuth		Europium		Niobium		Scandium	≤0.001
Lead	0.004	Samarium		Zirconium		Calcium	MC
Thallium		Neodymium		Yttrium	<0.001	Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.07	Chlorine	5
Gold		Cerium		Rubidium	0.02	Sulfur	>6
Platinum		Lanthanum		Bromine	0.04	Phosphorus	0.07
Iridium		Barium	0.05	Selenium	0.01	Silicon	1
Osmium		Cesium		Arsenic	≤0.004	Aluminum	>0.9
Rhenium		Iodine	0.004	Germanium		Magnesium	4
Tungsten		Tellurium		Gallium	0.001	Sodium	>2
Tantalum		Antimony		Zinc	0.03	Fluorine	≈4
Hafnium		Tin		Copper	0.006	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.02	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver		Iron	0.2	Boron	0.04
Erbium		Palladium		Manganese	0.01	Beryllium	
Holmium		Rhodium		Chromium	0.002	Lithium	0.003
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved:

Date: November 28, 1979

Analyst: J. Oldham

Sample No.: 18-01 10/11

IAD No.: 97-D398-377-22

Pond Water No. 2 Filtrate CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.006	Terbium		Ruthenium		Vanadium	0.001
Thorium	≤0.003	Gadolinium		Molybdenum	0.02	Titanium	0.2
Bismuth		Europium		Niobium		Scandium	<0.001
Lead	≤0.001	Samarium		Zirconium		Calcium	MC
Thallium		Neodymium		Yttrium		Potassium	>4
Mercury	NR	Praseodymium		Strontium	0.06	Chlorine	3
Gold		Cerium	<0.001	Rubidium	0.007	Sulfur	>2
Platinum		Lanthanum		Bromine	0.1	Phosphorus	0.06
Iridium		Barium	0.09	Selenium	0.002	Silicon	3
Osmium		Cesium	<0.001	Arsenic	≤0.001	Aluminum	>0.4
Rhenium		Iodine	0.007	Germanium		Magnesium	2
Tungsten		Tellurium		Gallium	<0.001	Sodium	>0.9
Tantalum		Antimony	<0.001	Zinc	0.01	Fluorine	≈0.3
Hafnium		Tin	0.003	Copper	0.005	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.006	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver		Iron	0.09	Boron	0.01
Erbium		Palladium		Manganese	0.002	Beryllium	
Holmium		Rhodium		Chromium	0.002	Lithium	0.002
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobs cmw

Date: November 28, 1979

Analyst: J. Oldham

Sample No.: 21-01 10/11

IAD No.: 97-0398-377-22

Pond No. 3 Filtrate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.006	Terbium		Ruthenium		Vanadium	0.006
Thorium	≤0.007	Gadolinium		Molybdenum *	0.009	Titanium	0.04
Bismuth		Europium		Niobium	<0.001	Scandium	<0.001
Lead		Samarium		Zirconium	0.002	Calcium	MC
Thallium		Neodymium		Yttrium	<0.001	Potassium	10
Mercury	NR	Praseodymium		Strontium	0.03	Chlorine	2
Gold		Cerium		Rubidium	0.02	Sulfur	>5
Platinum		Lanthanum		Bromine	0.03	Phosphorus	0.06
Iridium		Barium	0.09	Selenium	0.005	Silicon	7
Osmium		Cesium		Arsenic	0.002	Aluminum	>0.8
Rhenium		Iodine	0.02	Germanium		Magnesium	4
Tungsten		Tellurium		Gallium	0.001	Sodium	>2
Tantalum		Antimony		Zinc	0.005	Fluorine	≈6
Hafnium		Tin		Copper	0.005	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.03	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver		Iron	0.5	Boron	0.03
Erbium		Palladium		Manganese	0.01	Beryllium	
Holmium		Rhodium		Chromium	0.007	Lithium	0.003
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobs cm

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 24-01 10/10

IAD No.: 97-D398-377-22

Clean Coal Storage Pile Runoff CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.002
Thorium	* 0.3	Gadolinium		Molybdenum	≤0.004	Titanium	2
Bismuth		Europium		Niobium	≤0.001	Scandium	<0.001
Lead	0.003	Samarium		Zirconium	0.005	Calcium	MC
Thallium		Neodymium	0.006	Yttrium	0.02	Potassium	>9
Mercury	NR	Praseodymium	0.003	Strontium	3	Chlorine	MC
Gold		Cerium	0.02	Rubidium	<0.001	Sulfur	>4
Platinum		Lanthanum	0.07	Bromine	0.2	Phosphorus	0.01
Iridium		Barium	0.08	Selenium	0.004	Silicon	1
Osmium		Cesium		Arsenic	≤0.003	Aluminum	0.02
Rhenium		Iodine	≤0.001	Germanium	0.003	Magnesium	3
Tungsten		Tellurium		Gallium		Sodium	>2
Tantalum		Antimony		Zinc	0.5	Fluorine	≈0.2
Hafnium		Tin		Copper	0.009	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.5	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.02	Carbon	NR
Thulium		Silver		Iron	* 0.01	Boron	0.07
Erbium		Palladium		Manganese	0.4	Beryllium	
Holmium		Rhodium		Chromium	0.4	Lithium	0.01
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved:

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 26-01 10/11

IAD No.: 97-D398-377-22

Coarse Refuse Pile Vapor CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤2	Terbium		Ruthenium		Vanadium	0.1
Thorium	≤3	Gadolinium		Molybdenum	3	Titanium	9
Bismuth		Europium		Niobium		Scandium	≤0.2
Lead	2	Samarium		Zirconium	0.6	Calcium	160
Thallium		Neodymium		Yttrium	≤0.3	Potassium	210
Mercury	NR	Praseodymium		Strontium	0.7	Chlorine	160
Gold		Cerium		Rubidium	0.2	Sulfur	86
Platinum		Lanthanum		Bromine	7	Phosphorus	15
Iridium		Barium	7	Selenium		Silicon	53
Osmium		Cesium		Arsenic	≤0.3	Aluminum	17
Rhenium		Iodine	≤0.4	Germanium		Magnesium	4
Tungsten		Tellurium		Gallium		Sodium	290
Tantalum		Antimony		Zinc	23	Fluorine	≈0.5
Hafnium		Tin		Copper	12	Oxygen	NR
Lutecium		Indium	STD	Nickel	24	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.5	Carbon	NR
Thulium		Silver		Iron	37	Boron	0.3
Erbium		Palladium		Manganese	2	Beryllium	
Holmium		Rhodium		Chromium	4	Lithium	0.5
Dysprosium						Hydrogen	NR

NOTE: Sample ignited in Parr oxygen bomb according to EPA Level I

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.3 ppm
MC — Major Component
INT — Interference

Approved: ML Jacobs

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 27-01 10/11

IAD No.: 97-D398-377-22

Coarse Refuse Pile Runoff CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.01	Terbium		Ruthenium		Vanadium	0.002
Thorium	≤0.006	Gadolinium		Molybdenum	0.02	Titanium	0.2
Bismuth		Europium		Niobium	0.002	Scandium	<0.001
Lead	≤0.002	Samarium		Zirconium	0.001	Calcium	MC
Thallium		Neodymium		Yttrium	0.002	Potassium	>8
Mercury	NR	Praseodymium		Strontium	0.4	Chlorine	4
Gold		Cerium		Rubidium	0.006	Sulfur	>4
Platinum		Lanthanum		Bromine	0.06	Phosphorus	0.03
Iridium		Barium	0.03	Selenium	≤0.008	Silicon	0.6
Osmium		Cesium	<0.001	Arsenic	≤0.003	Aluminum	0.08
Rhenium		Iodine	0.03	Germanium	<0.001	Magnesium	MC
Tungsten		Tellurium		Gallium	0.001	Sodium	>2
Tantalum		Antimony		Zinc	0.04	Fluorine	≈2
Hafnium		Tin		Copper	0.002	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.04	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.001	Carbon	NR
Thulium		Silver		Iron	0.2	Boron *	0.1
Erbium		Palladium		Manganese	0.9	Beryllium	
Holmium		Rhodium		Chromium	<0.001	Lithium	0.01
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobs cnw

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 29-01 10/11

IAD No.: 97-D398-377-22

ROM Storage Pile Vapor

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.8	Terbium		Ruthenium		Vanadium	0.03
Thorium	≤1	Gadolinium		Molybdenum	1	Titanium	3
Bismuth		Europium		Niobium		Scandium	≤0.1
Lead	≤0.4	Samarium		Zirconium	≤2	Calcium	170
Thallium		Neodymium		Yttrium		Potassium	140
Mercury	NR	Praseodymium		Strontium	0.6	Chlorine	6
Gold		Cerium		Rubidium	0.2	Sulfur	35
Platinum	* 1	Lanthanum		Bromine	0.4	Phosphorus	5
Iridium		Barium	5	Selenium		Silicon	39
Osmium		Cesium		Arsenic	≤0.5	Aluminum	11
Rhenium		Iodine	≤0.1	Germanium		Magnesium	≤1
Tungsten		Tellurium		Gallium		Sodium	96
Tantalum		Antimony		Zinc	7	Fluorine	≈0.4
Hafnium		Tin		Copper	15	Oxygen	NR
Lutecium		Indium	STD	Nickel	5	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.9	Carbon	NR
Thulium		Silver		Iron	12	Boron	1
Erbium		Palladium		Manganese	0.5	Beryllium	
Holmium		Rhodium		Chromium	0.6	Lithium	0.4
Dysprosium						Hydrogen	NR

* Probable contamination from Parr oxygen bomb.

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved:

NOTE: Sample ignited in Parr oxygen bomb according to EPA Level I

Date: November 28, 1979

Analyst: J. Oldham

Sample No.: 30-01 10/11

IAD No.: 97-D398-377-22

ROM Storage Pile Runoff

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.01	Terbium		Ruthenium		Vanadium	<0.001
Thorium	≤0.02	Gadolinium		Molybdenum	0.01	Titanium	0.9
Bismuth		Europium		Niobium	≤0.002	Scandium	≤0.002
Lead	≤0.007	Samarium		Zirconium	0.004	Calcium	MC
Thallium		Neodymium		Yttrium	≤0.006	Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.3	Chlorine	5
Gold		Cerium		Rubidium		Sulfur	MC
Platinum		Lanthanum		Bromine	0.04	Phosphorus	0.08
Iridium		Barium	0.05	Selenium		Silicon	0.3
Osmium		Cesium		Arsenic	≤0.008	Aluminum	0.01
Rhenium		Iodine	≤0.002	Germanium		Magnesium	9
Tungsten		Tellurium		Gallium	0.002	Sodium	>5
Tantalum		Antimony		Zinc	0.03	Fluorine	≈2
Hafnium		Tin		Copper	0.003	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.03	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.003	Carbon	NR
Thulium		Silver		Iron	0.1	Boron	0.02
Erbium		Palladium		Manganese	0.1	Beryllium	
Holmium		Rhodium		Chromium	≤0.005	Lithium	0.001
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected <0.002 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobs cmw

Date: November 29, 1979

Analyst: J. Oldham

Sample No.: 32-01 10/16

IAD No.: 97-D398-377-22

Upwind Vapor

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤2	Terbium		Ruthenium		Vanadium	0.2
Thorium	≤2	Gadolinium		Molybdenum	3	Titanium	27
Bismuth		Europium		Niobium		Scandium	≤0.06
Lead	1	Samarium		Zirconium	≤1	Calcium	58
Thallium		Neodymium		Yttrium	0.6	Potassium	310
Mercury	NR	Praseodymium		Strontium	0.1	Chlorine	130
Gold		Cerium		Rubidium		Sulfur	31
Platinum	* 6	Lanthanum		Bromine	5	Phosphorus	10
Iridium		Barium	1	Selenium		Silicon	350
Osmium		Cesium		Arsenic	≤0.1	Aluminum	28
Rhenium		Iodine	1	Germanium		Magnesium	10
Tungsten		Tellurium		Gallium		Sodium	73
Tantalum		Antimony		Zinc	7	Fluorine	≃0.2
Hafnium		Tin		Copper	8	Oxygen	NR
Lutecium		Indium	STD	Nickel	4	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.8	Carbon	NR
Thulium		Silver	≤0.2	Iron	25	Boron	0.2
Erbium		Palladium		Manganese	0.3	Beryllium	
Holmium		Rhodium		Chromium	1	Lithium	0.03
Dysprosium						Hydrogen	NR

* Probable contamination from Parr oxygen bomb.

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.2 ppm
MC — Major Component
INT — Interference

Approved:

NOTE: Sample ignited in Parr oxygen bomb according to EPA Level I

Date: November 26, 1979

Analyst: J. Oldham

Sample No.: 45-01 A 10/22

IAD No.: 97-D398-377-22

Blind Clean Coal

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	3	Terbium	0.1	Ruthenium		Vanadium	150
Thorium	4	Gadolinium	0.5	Molybdenum	10	Titanium	MC
Bismuth		Europium	0.2	Niobium	10	Scandium	1
Lead	7	Samarium	2	Zirconium	59	Calcium	MC
Thallium	≤1	Neodymium	1	Yttrium	7	Potassium	MC
Mercury	NR	Praseodymium	1	Strontium	32	Chlorine	130
Gold		Cerium	13	Rubidium	20	Sulfur	>560
Platinum		Lanthanum	9	Bromine	3	Phosphorus	160
Iridium		Barium	240	Selenium	5	Silicon	MC
Osmium		Cesium	1	Arsenic	8	Aluminum	>90
Rhenium		Iodine	0.9	Germanium	5	Magnesium	MC
Tungsten		Tellurium	0.3	Gallium	3	Sodium	>230
Tantalum		Antimony	0.7	Zinc	13	Fluorine	≈32
Hafnium		Tin	0.4	Copper	10	Oxygen	NR
Lutecium		Indium	STD	Nickel	4	Nitrogen	NR
Ytterbium		Cadmium	≤0.2	Cobalt	2	Carbon	NR
Thulium		Silver		Iron	MC	Boron	68
Erbium	0.2	Palladium		Manganese	46	Beryllium	0.2
Holmium	0.3	Rhodium		Chromium	10	Lithium	3
Dysprosium	0.4					Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved:

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 22-01 10/11
Clean Coal Storage
Pile Particulates

IAD No.: 97-D415-377-06

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.001	Terbium		Ruthenium		Vanadium	0.02
Thorium	≤0.002	Gadolinium		Molybdenum	0.002	Titanium	MC
Bismuth		Europium		Niobium	0.004	Scandium	0.001
Lead	0.02	Samarium		Zirconium	0.03	Calcium	MC
Thallium		Neodymium	0.001	Yttrium	0.003	Potassium	MC
Mercury	NR	Praseodymium	0.001	Strontium	0.08	Chlorine	0.5
Gold		Cerium	0.005	Rubidium	0.004	Sulfur	MC
Platinum		Lanthanum	0.008	Bromine	0.02	Phosphorus	0.3
Iridium		Barium	0.1	Selenium	≤0.005	Silicon	MC
Osmium		Cesium	0.0003	Arsenic	0.004	Aluminum	>0.2
Rhenium		Iodine	0.0009	Germanium		Magnesium	MC
Tungsten		Tellurium		Gallium	0.005	Sodium	>0.5
Tantalum		Antimony		Zinc	0.06	Fluorine	≈0.07
Hafnium		Tin	≤0.0003	Copper	0.007	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.008	Nitrogen	NR
Ytterbium		Cadmium	≤0.0004	Cobalt	0.002	Carbon	NR
Thulium		Silver		Iron	MC	Boron	0.08
Erbium		Palladium		Manganese	0.2	Beryllium	0.0001
Holmium		Rhodium		Chromium	0.006	Lithium	0.003
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected $< 0.00002\ \mu g/cm^2$
MC — Major Component $> 1\ \mu g/cm^2$
INT — Interference

Approved: ML Jacobs cav

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 25-01 10/12
Coarse Refuse
Pile Particulates

IAD No.: 97-D415-377-06

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.002	Terbium		Ruthenium		Vanadium	0.002
Thorium	≤0.003	Gadolinium		Molybdenum	0.002	Titanium	0.04
Bismuth		Europium		Niobium	0.0004	Scandium	≤0.0002
Lead	0.006	Samarium		Zirconium	* 0.002	Calcium	MC
Thallium		Neodymium		Yttrium	0.0004	Potassium	MC
Mercury	NR	Praseodymium	0.0004	Strontium	0.005	Chlorine	0.4
Gold		Cerium	0.002	Rubidium	0.0006	Sulfur	0.3
Platinum		Lanthanum	0.002	Bromine	0.007	Phosphorus	0.02
Iridium		Barium	0.009	Selenium	0.002	Silicon	MC
Osmium		Cesium		Arsenic	≤0.0003	Aluminum	0.1
Rhenium		Iodine		Germanium		Magnesium	0.7
Tungsten		Tellurium		Gallium	0.0004	Sodium	>0.8
Tantalum		Antimony		Zinc	0.02	Fluorine	≈0.3
Hafnium		Tin		Copper	0.004	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.005	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.0002	Carbon	NR
Thulium		Silver		Iron	0.2	Boron	0.1
Erbium		Palladium		Manganese	* 0.004	Beryllium	<0.0001
Holmium		Rhodium		Chromium	0.004	Lithium	0.001
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected $< 0.0002\ \mu g/cm^2$
MC — Major Component $> 1\ \mu g/cm^2$
INT — Interference

Approved: MJ Jacobs

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 28-01 10/11
ROM Storage
Pile Particulates

IAD No.: 97-D415-377-06

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.001	Terbium	0.0002	Ruthenium		Vanadium	0.03
Thorium	0.002	Gadolinium	0.0004	Molybdenum	0.003	Titanium	0.4
Bismuth		Europium	0.0002	Niobium	0.003	Scandium	* 0.0004
Lead	0.01	Samarium	0.001	Zirconium	* 0.009	Calcium	MC
Thallium		Neodymium	0.002	Yttrium	0.002	Potassium	MC
Mercury	NR	Praseodymium	0.0008	Strontium	0.1	Chlorine	0.2
Gold		Cerium	0.02	Rubidium	0.01	Sulfur	>0.9
Platinum		Lanthanum	0.007	Bromine	0.005	Phosphorus	0.3
Iridium		Barium	0.2	Selenium	0.002	Silicon	MC
Osmium		Cesium	0.001	Arsenic	0.003	Aluminum	>0.1
Rhenium		Iodine	0.0007	Germanium	≤0.0003	Magnesium	MC
Tungsten		Tellurium	0.0003	Gallium	0.005	Sodium	>0.4
Tantalum		Antimony	0.0003	Zinc	0.04	Fluorine	≈0.1
Hafnium		Tin	0.0006	Copper	0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.006	Nitrogen	NR
Ytterbium		Cadmium	0.0005	Cobalt	0.01	Carbon	NR
Thulium		Silver	≤0.0003	Iron	MC	Boron	0.08
Erbium		Palladium		Manganese	0.3	Beryllium	<0.0001
Holmium		Rhodium		Chromium	0.02	Lithium	0.005
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.00001 $\mu g/cm^2$
MC — Major Component > 1 $\mu g/cm^2$
INT — Interference

Approved: M J Jacobs

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 31-01 10/15

IAD No.: 97-D415-377-06

Upwind Particulates

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.0003	Terbium		Ruthenium		Vanadium	0.008
Thorium	0.0004	Gadolinium		Molybdenum	0.0006	Titanium	MC
Bismuth		Europium		Niobium	0.001	Scandium	0.0002
Lead	0.02	Samarium	0.0002	Zirconium	0.003	Calcium	MC
Thallium		Neodymium	0.0005	Yttrium	0.0007	Potassium	>0.6
Mercury	NR	Praseodymium	0.0006	Strontium	0.03	Chlorine	0.03
Gold		Cerium	0.003	Rubidium	0.02	Sulfur	>0.3
Platinum		Lanthanum	0.005	Bromine	0.009	Phosphorus	0.5
Iridium		Barium	0.05	Selenium		Silicon	MC
Osmium		Cesium	0.0007	Arsenic	0.002	Aluminum	>0.04
Rhenium		Iodine	0.0006	Germanium	0.0001	Magnesium	MC
Tungsten		Tellurium		Gallium	0.001	Sodium	>0.1
Tantalum		Antimony	0.0004	Zinc	0.03	Fluorine	≈0.06
Hafnium		Tin	0.0002	Copper	0.006	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.002	Nitrogen	NR
Ytterbium		Cadmium	0.0001	Cobalt	0.003	Carbon	NR
Thulium		Silver	<0.0001	Iron	MC	Boron	0.01
Erbium		Palladium		Manganese	0.2	Beryllium	<0.0001
Holmium		Rhodium		Chromium	0.005	Lithium	0.0007
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected $< 0.0001\ \mu g/cm^2$
MC — Major Component $> 1\ \mu g/cm^2$
INT — Interference

Approved: ML Jacobson

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 34-01 10/15

IAD No.: 97-D415-377-06

Downwind Particulates CONCENTRATION IN μg/cm^2

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.0004	Terbium		Ruthenium		Vanadium	0.005
Thorium	<0.0006	Gadolinium		Molybdenum	<0.001	Titanium	0.2
Bismuth		Europium		Niobium	<0.001	Scandium	<0.0001
Lead	0.03	Samarium		Zirconium	* 0.002	Calcium	MC
Thallium		Neodymium	≤0.0001	Yttrium	0.0005	Potassium	>0.9
Mercury	NR	Praseodymium	0.0002	Strontium	0.05	Chlorine	0.03
Gold		Cerium	0.002	Rubidium	0.006	Sulfur	>0.4
Platinum		Lanthanum	0.002	Bromine	0.006	Phosphorus	0.1
Iridium		Barium	* 0.08	Selenium	≤0.0002	Silicon	MC
Osmium		Cesium	0.0004	Arsenic	0.001	Aluminum	>0.07
Rhenium		Iodine	<0.0001	Germanium	<0.0001	Magnesium	MC
Tungsten		Tellurium		Gallium	<0.0001	Sodium	>0.2
Tantalum		Antimony		Zinc	0.05	Fluorine	≈0.06
Hafnium		Tin		Copper	0.01	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.001	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.0005	Carbon	NR
Thulium		Silver		Iron	0.8	Boron	0.07
Erbium		Palladium		Manganese	0.04	Beryllium	<0.0001
Holmium		Rhodium		Chromium	0.006	Lithium	0.0009
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.0001 μg/cm^2
MC — Major Component > 1 μg/cm^2
INT — Interference

Approved: Ml Jacobs chr

Date: December 7, 1979

Analyst: J. Oldham

Sample No.: 44-01 10/23

IAD No.: 97-D415-377-06

Blank Filter

CONCENTRATION IN µg/cm²

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.002	Terbium		Ruthenium		Vanadium	0.0004
Thorium	0.002	Gadolinium		Molybdenum	≤0.001	Titanium	* 0.03
Bismuth		Europium		Niobium		Scandium	≤0.0001
Lead	0.002	Samarium		Zirconium	0.0007	Calcium	MC
Thallium		Neodymium		Yttrium		Potassium	0.4
Mercury	NR	Praseodymium	0.0003	Strontium	0.0009	Chlorine	0.01
Gold		Cerium	* 0.003	Rubidium	0.0002	Sulfur	* 0.07
Platinum		Lanthanum	* 0.005	Bromine	0.002	Phosphorus	0.02
Iridium		Barium	0.06	Selenium		Silicon	0.8
Osmium		Cesium		Arsenic	0.0001	Aluminum	0.03
Rhenium		Iodine		Germanium		Magnesium	0.3
Tungsten		Tellurium		Gallium		Sodium	>0.6
Tantalum		Antimony		Zinc	0.01	Fluorine	≈0.04
Hafnium		Tin		Copper	0.008	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.0009	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.0004	Carbon	NR
Thulium		Silver		Iron	0.1	Boron	0.02
Erbium		Palladium		Manganese	0.003	Beryllium	
Holmium		Rhodium		Chromium	0.001	Lithium	0.0008
Dysprosium						Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.0002 µg/cm²
MC — Major Component > 1 µg/cm²
INT — Interference

Approved: ML Jacobs

Date: December 5, 1979

Analyst: J. Oldham

Sample No.: 35-01 10/16

IAD No.: 97-D398-377-22

Downwind Vapors

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.5	Terbium		Ruthenium		Vanadium	1
Thorium	≤0.7	Gadolinium		Molybdenum	7	Titanium	9
Bismuth		Europium		Niobium	1	Scandium	<0.1
Lead	1	Samarium		Zirconium		Calcium	430
Thallium		Neodymium	0.2	Yttrium	<0.1	Potassium	94
Mercury	NR	Praseodymium	0.3	Strontium	1	Chlorine	43
Gold		Cerium	1	Rubidium	<0.1	Sulfur	160
Platinum	* 2	Lanthanum	2	Bromine	1	Phosphorus	33
Iridium		Barium	8	Selenium		Silicon	120
Osmium		Cesium	0.5	Arsenic	0.4	Aluminum	>76
Rhenium		Iodine	<0.1	Germanium	<0.1	Magnesium	16
Tungsten		Tellurium		Gallium	≤0.3	Sodium	>190
Tantalum		Antimony		Zinc	13	Fluorine	≈12
Hafnium		Tin		Copper	82	Oxygen	NR
Lutecium		Indium	STD	Nickel	MC	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	15	Carbon	NR
Thulium		Silver	0.8	Iron	460	Boron	0.3
Erbium		Palladium		Manganese	17	Beryllium	<0.1
Holmium		Rhodium		Chromium	39	Lithium	0.5
Dysprosium						Hydrogen	NR

* Probable contamination from Parr oxygen bomb.

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved:

NOTE: Sample ignited in Parr oxygen bomb according to EPA Level I

Date: December 5, 1979

Analyst: J. Oldham

Sample No.: 43-01 10/16

IAD No.: 97-D398-377-22

Blank XAD Resin

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.8	Terbium		Ruthenium		Vanadium	<0.1
Thorium	≤1	Gadolinium		Molybdenum	1	Titanium	3
Bismuth		Europium		Niobium	≤0.2	Scandium	≤0.1
Lead	≤0.5	Samarium		Zirconium	0.3	Calcium	270
Thallium		Neodymium		Yttrium	≤0.1	Potassium	290
Mercury	NR	Praseodymium		Strontium	5	Chlorine	27
Gold		Cerium	≤0.2	Rubidium	<0.1	Sulfur	9
Platinum	** 1	Lanthanum	0.5	Bromine	1	Phosphorus	9
Iridium		Barium	3	Selenium	≤0.2	Silicon	41
Osmium		Cesium	0.2	Arsenic	0.1	Aluminum	13
Rhenium		Iodine	0.2	Germanium	≤0.3	Magnesium	44
Tungsten		Tellurium	≤0.2	Gallium	≤0.1	Sodium	100
Tantalum		Antimony		Zinc	20	Fluorine	≈10
Hafnium		Tin		Copper	4	Oxygen	NR
Lutecium		Indium	STD	Nickel	42	Nitrogen	NR
Ytterbium		Cadmium	* 0.4	Cobalt	0.2	Carbon	NR
Thulium		Silver		Iron	29	Boron	* 0.1
Erbium		Palladium		Manganese	0.6	Beryllium	
Holmium		Rhodium		Chromium	1	Lithium	0.4
Dysprosium						Hydrogen	NR

*Heterogeneous

**Probable contamination from Parr oxygen bomb.

STD — Internal Standard

NR — Not Reported

All elements not detected < 0.1 ppm

MC — Major Component

INT — Interference

Approved: M L Jacobs

NOTE: Sample ignited in Parr oxygen bomb according to EPA Level I

Date: December 6, 1979

Analyst: J. Oldham

Sample No.: 23-01 10/11
Clean Coal Storage
Pile Vapor

IAD No.: 97-D398-377-22

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.3	Terbium		Ruthenium		Vanadium	<0.1
Thorium	≤0.4	Gadolinium		Molybdenum	1	Titanium	1
Bismuth		Europium		Niobium	<0.1	Scandium	<0.1
Lead	0.4	Samarium		Zirconium	0.1	Calcium	64
Thallium		Neodymium		Yttrium		Potassium	550
Mercury	NR	Praseodymium	0.1	Strontium	0.2	Chlorine	2
Gold		Cerium	0.3	Rubidium	<0.1	Sulfur	32
Platinum	* 0.5	Lanthanum	1	Bromine	1	Phosphorus	3
Iridium		Barium	1	Selenium		Silicon	7
Osmium		Cesium	0.1	Arsenic	<0.1	Aluminum	5
Rhenium		Iodine	<0.1	Germanium		Magnesium	5
Tungsten		Tellurium		Gallium	<0.1	Sodium	>120
Tantalum		Antimony		Zinc	7	Fluorine	≈2
Hafnium		Tin		Copper	3	Oxygen	NR
Lutecium		Indium	STD	Nickel	6	Nitrogen	NR
Ytterbium		Cadmium	≤0.1	Cobalt	0.3	Carbon	NR
Thulium		Silver		Iron	4	Boron	1
Erbium		Palladium		Manganese	0.9	Beryllium	<0.1
Holmium		Rhodium		Chromium	0.5	Lithium	0.2
Dysprosium						Hydrogen	NR

* Probable contamination from Parr Oxygen Bomb.

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: M Jacobs

NOTE: Sample ignited in Parr Oxygen Bomb according to EPA Level I

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: (01-01) correction 37-01

IAD No.: 97-D601-377-10

Clean Coal Leachate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.01	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.01	Gadolinium		Molybdenum	0.02	Titanium	0.05
Bismuth		Europium		Niobium		Scandium	≤0.002
Lead	≤0.006	Samarium		Zirconium	≤0.01	Calcium	MC
Thallium		Neodymium		Yttrium	0.01	Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.2	Chlorine	0.3
Gold		Cerium		Rubidium	0.003	Sulfur	MC
Platinum		Lanthanum		Bromine	0.1	Phosphorus	0.007
Iridium		Barium	0.04	Selenium	0.002	Silicon	2
Osmium		Cesium		Arsenic	≤0.001	Aluminum	0.03
Rhenium		Iodine		Germanium		Magnesium	7
Tungsten		Tellurium		Gallium	≤0.002	Sodium	>4
Tantalum		Antimony		Zinc	0.5	Fluorine	≈1
Hafnium		Tin		Copper	0.009	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.03	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.03	Carbon	NR
Thulium		Silver		Iron	0.1	Boron	0.03
Erbium		Palladium		Manganese	0.8	Beryllium	
Holmium		Rhodium		Chromium	0.004	Lithium	0.006
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: MLJacobs crw

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 05-01 correction 38-01

ROM Coal Leachate

IAD No.: 97-D601-377-10

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.007	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.009	Gadolinium		Molybdenum	0.01	Titanium	0.1
Bismuth		Europium		Niobium	0.001	Scandium	≤0.001
Lead	0.005	Samarium		Zirconium	0.003	Calcium	MC
Thallium		Neodymium		Yttrium	0.003	Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.2	Chlorine	0.6
Gold		Cerium		Rubidium	0.009	Sulfur	>6
Platinum		Lanthanum		Bromine	0.09	Phosphorus	0.02
Iridium		Barium	0.05	Selenium	0.006	Silicon	2
Osmium		Cesium		Arsenic	0.001	Aluminum	0.05
Rhenium		Iodine		Germanium		Magnesium	5
Tungsten		Tellurium		Gallium	<0.001	Sodium	>3
Tantalum	*≤0.006	Antimony		Zinc	0.03	Fluorine	≈0.9
Hafnium		Tin	0.004	Copper	0.01	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.2	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.008	Carbon	NR
Thulium		Silver		Iron	0.05	Boron	0.02
Erbium		Palladium		Manganese	0.1	Beryllium	
Holmium		Rhodium		Chromium	0.005	Lithium	0.01
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 g/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: ML Jacobs caw

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 06-01 Correction 39-01

IAD No.: 97-D601-377-10

Coarse Refuse Leachate CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.04	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.004	Gadolinium		Molybdenum	0.2	Titanium	0.3
Bismuth		Europium		Niobium	<0.001	Scandium	<0.001
Lead	0.004	Samarium		Zirconium	0.001	Calcium	MC
Thallium		Neodymium		Yttrium	<0.001	Potassium	>6
Mercury	NR	Praseodymium		Strontium	0.08	Chlorine	0.03
Gold		Cerium		Rubidium	0.02	Sulfur	>3
Platinum		Lanthanum		Bromine	0.1	Phosphorus	0.008
Iridium		Barium	0.05	Selenium	0.03	Silicon	0.4
Osmium		Cesium	<0.001	Arsenic	<0.001	Aluminum	0.02
Rhenium		Iodine	<0.001	Germanium		Magnesium	1
Tungsten		Tellurium		Gallium	<0.001	Sodium	>1
Tantalum		Antimony	0.004	Zinc	0.3	Fluorine	≈0.4
Hafnium		Tin		Copper	0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.003	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver		Iron	0.03	Boron	0.04
Erbium		Palladium		Manganese	0.02	Beryllium	
Holmium		Rhodium		Chromium	<0.001	Lithium	0.007
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: ML Jacobs

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 07-01 *Correction 40-01*

IAD No.: 97-D601-377-10

Pond No. 1 Sediment Leachate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.007	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.007	Gadolinium		Molybdenum	0.04	Titanium	0.04
Bismuth		Europium		Niobium	0.004	Scandium	<0.001
Lead	0.004	Samarium		Zirconium	0.002	Calcium	MC
Thallium		Neodymium		Yttrium	0.002	Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.1	Chlorine	0.2
Gold		Cerium		Rubidium	0.005	Sulfur	>5
Platinum		Lanthanum		Bromine	0.06	Phosphorus	0.01
Iridium		Barium	0.09	Selenium	0.002	Silicon	0.3
Osmium		Cesium		Arsenic	<0.001	Aluminum	0.03
Rhenium		Iodine	<0.001	Germanium		Magnesium	0.9
Tungsten		Tellurium		Gallium		Sodium	>2
Tantalum		Antimony		Zinc	0.02	Fluorine	≈1
Hafnium		Tin		Copper	0.01	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.006	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver		Iron	0.5	Boron	<0.001
Erbium		Palladium		Manganese	0.1	Beryllium	
Holmium		Rhodium		Chromium	*0.02	Lithium	0.003
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: MLJacobs caw

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 08-01 Correction 41-01

IAD No.: 97-D601-377-10

Pond No. 2 Sediment Leachate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.005	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.006	Gadolinium		Molybdenum	0.03	Titanium	0.02
Bismuth		Europium		Niobium	<0.001	Scandium	<0.001
Lead	<0.002	Samarium		Zirconium	0.002	Calcium	8
Thallium		Neodymium		Yttrium		Potassium	3
Mercury	NR	Praseodymium		Strontium	0.04	Chlorine	0.04
Gold		Cerium		Rubidium		Sulfur	>4
Platinum		Lanthanum		Bromine	0.01	Phosphorus	0.01
Iridium		Barium	0.03	Selenium	0.002	Silicon	1
Osmium		Cesium		Arsenic	*<0.001	Aluminum	0.01
Rhenium		Iodine	0.008	Germanium		Magnesium	1
Tungsten		Tellurium		Gallium		Sodium	>2
Tantalum		Antimony		Zinc	0.04	Fluorine	*≈0.2
Hafnium		Tin		Copper	*0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	*0.005	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver		Iron	*0.04	Boron	0.002
Erbium		Palladium		Manganese	0.2	Beryllium	
Holmium		Rhodium		Chromium	<0.001	Lithium	<0.001
Dysprosium			*Heterogeneous			Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: ML Jacobs

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 09-01 correction 42-01

IAD No.: 97-D601-377-10

Pond No. 3 Sediment Leachate

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.007	Terbium		Ruthenium		Vanadium	*0.007
Thorium	<0.008	Gadolinium		Molybdenum	*0.1	Titanium	*0.1
Bismuth		Europium		Niobium	0.002	Scandium	0.002
Lead	0.008	Samarium		Zirconium	0.003	Calcium	MC
Thallium		Neodymium		Yttrium		Potassium	2
Mercury	NR	Praseodymium		Strontium	0.2	Chlorine	0.02
Gold		Cerium	0.001	Rubidium	<0.001	Sulfur	>6
Platinum		Lanthanum		Bromine	0.02	Phosphorus	*0.02
Iridium		Barium	0.03	Selenium	0.006	Silicon	*0.8
Osmium		Cesium		Arsenic		Aluminum	*0.05
Rhenium		Iodine	0.01	Germanium		Magnesium	1
Tungsten		Tellurium		Gallium		Sodium	>2
Tantalum		Antimony		Zinc	0.03	Fluorine	≈0.3
Hafnium		Tin		Copper	0.006	Oxygen	NR
Lutecium		Indium	STD	Nickel	*0.02	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver		Iron	*0.6	Boron	<0.001
Erbium		Palladium		Manganese	0.2	Beryllium	<0.001
Holmium		Rhodium		Chromium	*0.001	Lithium	0.006
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: ML Jacobs caw

Date: December 28, 1979

Analyst: J. Oldham

Sample No.: 45-01

IAD No.: 97-0601-377-10

Leachate Blank Batch #1

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.01	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.01	Gadolinium		Molybdenum	0.4	Titanium	*0.5
Bismuth		Europium		Niobium		Scandium	<0.001
Lead	0.007	Samarium		Zirconium	0.005	Calcium	0.9
Thallium		Neodymium		Yttrium		Potassium	0.4
Mercury	NR	Praseodymium		Strontium	0.007	Chlorine	0.1
Gold		Cerium		Rubidium		Sulfur	0.1
Platinum		Lanthanum		Bromine	0.04	Phosphorus	0.1
Iridium		Barium	0.02	Selenium		Silicon	2
Osmium		Cesium		Arsenic	<0.001	Aluminum	0.08
Rhenium		Iodine		Germanium		Magnesium	0.7
Tungsten	≤0.006	Tellurium		Gallium		Sodium	0.5
Tantalum		Antimony		Zinc	0.5	Fluorine	≈0.2
Hafnium		Tin		Copper	0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.006	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver		Iron	0.1	Boron	<0.001
Erbium		Palladium		Manganese	0.002	Beryllium	
Holmium		Rhodium		Chromium	<0.001	Lithium	<0.001
Dysprosium			*Heterogeneous			Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component >10 µg/ml
INT — Interference

Approved: MLJacobs caw

Date: January 2, 1980

Analyst: J. Oldham

Sample No.: 47-01

IAD No.: 97-D601-377-10

Leachate Method Standard

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.04	Terbium		Ruthenium		Vanadium	0.01
Thorium	0.05	Gadolinium		Molybdenum	0.1	Titanium	0.6
Bismuth		Europium		Niobium		Scandium	≤0.003
Lead	4	Samarium		Zirconium	0.03	Calcium	2
Thallium		Neodymium		Yttrium		Potassium	MC
Mercury	NR	Praseodymium		Strontium	0.008	Chlorine	6
Gold		Cerium		Rubidium		Sulfur	MC
Platinum		Lanthanum		Bromine	0.1	Phosphorus	0.07
Iridium		Barium	MC	Selenium		Silicon	* 2
Osmium		Cesium		Arsenic	≤0.008	Aluminum	2
Rhenium		Iodine		Germanium		Magnesium	2
Tungsten		Tellurium		Gallium		Sodium	1
Tantalum		Antimony		Zinc	3	Fluorine	≈0.2
Hafnium		Tin		Copper	0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.07	Nitrogen	NR
Ytterbium		Cadmium	2	Cobalt	≤0.004	Carbon	NR
Thulium		Silver		Iron	5	Boron	<0.001
Erbium		Palladium		Manganese	0.06	Beryllium	
Holmium		Rhodium		Chromium	MC	Lithium	
Dysprosium		* Heterogeneous				Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected <0.004 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: ML Jacobson

Date: January 2, 1980

Analyst: J. Oldham

Sample No.: 48-01
Duplicate Pond No. 2
Sediment Leachate

IAD No.: 97-D601-377-10

CONCENTRATION IN μg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.01	Terbium		Ruthenium		Vanadium	<0.001
Thorium	<0.01	Gadolinium		Molybdenum	0.02	Titanium	0.2
Bismuth		Europium		Niobium		Scandium	≤0.002
Lead	<0.006	Samarium		Zirconium	0.02	Calcium	MC
Thallium		Neodymium		Yttrium		Potassium	3
Mercury	NR	Praseodymium		Strontium	0.03	Chlorine	0.2
Gold		Cerium		Rubidium		Sulfur	MC
Platinum		Lanthanum		Bromine	0.06	Phosphorus	0.03
Iridium		Barium	0.05	Selenium		Silicon	5
Osmium		Cesium		Arsenic	<0.001	Aluminum	0.03
Rhenium		Iodine	0.008	Germanium		Magnesium	0.8
Tungsten		Tellurium		Gallium	≤0.001	Sodium	>4
Tantalum		Antimony		Zinc	0.03	Fluorine	≈2
Hafnium		Tin		Copper	0.01	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.01	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.003	Carbon	NR
Thulium		Silver		Iron	0.04	Boron	<0.001
Erbium		Palladium		Manganese	0.2	Beryllium	
Holmium		Rhodium		Chromium	<0.001	Lithium	0.002
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected <0.001 μg/ml
MC — Major Component > 10 μg/ml
INT — Interference

Approved: ML Jacobs caw

Date: January 2, 1980

Analyst: J. Oldham

Sample No.: 46-01
Leachate Blank
Batch #2

IAD No.: 97-D601-377-10

CONCENTRATION IN µg/ml

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.01	Terbium		Ruthenium		Vanadium	0.001
Thorium	<0.01	Gadolinium		Molybdenum	0.04	Titanium	0.08
Bismuth		Europium		Niobium	≤0.003	Scandium	<0.001
Lead	<0.006	Samarium		Zirconium	0.03	Calcium	* 0.4
Thallium		Neodymium		Yttrium		Potassium	0.2
Mercury	NR	Praseodymium		Strontium	0.001	Chlorine	0.2
Gold		Cerium		Rubidium		Sulfur	0.05
Platinum		Lanthanum		Bromine	0.006	Phosphorus	0.007
Iridium		Barium	0.004	Selenium		Silicon	0.07
Osmium		Cesium		Arsenic	≤0.003	Aluminum	0.02
Rhenium		Iodine		Germanium		Magnesium	≤0.01
Tungsten		Tellurium		Gallium		Sodium	0.08
Tantalum		Antimony	0.005	Zinc	0.03	Fluorine	≈0.02
Hafnium		Tin		Copper	0.02	Oxygen	NR
Lutecium		Indium	STD	Nickel	0.006	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver		Iron	0.09	Boron	
Erbium		Palladium		Manganese	0.002	Beryllium	
Holmium		Rhodium		Chromium	0.007	Lithium	
Dysprosium		* Heterogeneous				Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/ml
MC — Major Component > 10 µg/ml
INT — Interference

Approved: MLJacobson

APPENDIX B

INDUCTIVELY COUPLED ARGON PLASMA DATA FOR LIQUID SAMPLES

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 45-01 Leachate Blank - Batch #1

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	80	<10	MAGNESIUM	700	10
ANTIMONY	<1	<10	MANGANESE	2	<1
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	20	<1	MOLYBDENUM	400	<4
BERYLLIUM	<1	<1	NICKEL	6	<5
BORON	<1	<1	POTASSIUM	400	<100
CADMIUM	<1	<2	SELENIUM	<1	N.R.
CALCIUM	900	527	SILVER	<1	<30
CHROMIUM	<1	<2	SODIUM	500	208
COBALT	≤1	<2	STRONTIUM	7	<1
COPPER	20	<1	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	500	<1
IRON	100	<1	VANADIUM	<1	<5
LEAD	7	<30	YTTRIUM	<1	<1
LITHIUM	<1	<1	ZINC	500	<2

N.R. - Not Reported

INT - Interference

*(N)- Mean of (N) Analysis

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 46-01 Leachate Blank - Batch #2

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	20	<10	MAGNESIUM	≤10	3
ANTIMONY	5	<10	MANGANESE	2	<1
ARSENIC	≤3	N.R.	MERCURY	N.R.	N.R.
BARIUM	4	<1	MOLYBDENUM	40	<4
BERYLLIUM	<1	<1	NICKEL	6	<5
BORON	<1	<1	POTASSIUM	200	<100
CADMIUM	<1	<2	SELENIUM	<1	N.R.
CALCIUM	400	31	SILVER	<1	<30
CHROMIUM	7	<2	SODIUM	80	164
COBALT	≤1	<2	STRONTIUM	1	<1
COPPER	20	<1	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	80	<1
IRON	90	<1	VANADIUM	1	<5
LEAD	<6	<30	YTTRIUM	<1	<1
LITHIUM	<1	<1	ZINC	30	<2

N.R. - Not Reported
INT - Interference
*(N) - Mean of (N) Analysis

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 01-01 Clean Coal Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	30	20	MAGNESIUM	7,000	3,980
ANTIMONY	<1	<10	MANGANESE	800	561
ARSENIC	≤1	N.R.	MERCURY	N.R.	N.R.
BARIUM	40	26	MOLYBDENUM	20	<4
BERYLLIUM	<1	<1	NICKEL	30	20
BORON	30	323	POTASSIUM	MC	4,200
CADMIUM	<1	<2	SELENIUM	2	N.R.
CALCIUM	MC	119,000	SILVER	<1	<30
CHROMIUM	4	<2	SODIUM	<4,000	60,600
COBALT	30	9	STRONTIUM	200	266
COPPER	9	1	TIN	<1	<10
GALLIUM	≤2	<20	TITANIUM	50	1
IRON	100	8	VANADIUM	<1	<5
LEAD	≤6	<30	YTTRIUM	10	<1
LITHIUM	6	10	ZINC	500	157

N.R. - Not Reported

INT - Interference

*(N) - Mean of (N) Analysis

MG - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 06-01 ROM Coal Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	20	10	MAGNESIUM	1,000	1,490
ANTIMONY	4	<10	MANGANESE	20	21
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	50	20	MOLYBDENUM	200	357
BERYLLIUM	<1	<1	NICKEL	3	<5
BORON	40	557	POTASSIUM	<6,000	11,400
CADMIUM	<1	<2	SELENIUM	30	N.R.
CALCIUM	MC	15,500	SILVER	<1	<30
CHROMIUM	<1	<2	SODIUM	<1,000	334,000
COBALT	<1	<2	STRONTIUM	80	121
COPPER	20	1	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	300	<1
IRON	30	14	VANADIUM	<1	<5
LEAD	4	<30	YTTRIUM	<1	<1
LITHIUM	7	31	ZINC	300	54

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 05-01 Coarse Refuse Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	50	<10	MAGNESIUM	5,000	2,370
ANTIMONY	<1	<10	MANGANESE	100	58
ARSENIC	1	N.R.	MERCURY	N.R.	N.R.
BARIUM	50	24	MOLYBDENUM	10	5
BERYLLIUM	<1	<1	NICKEL	200	<5
BORON	20	444	POTASSIUM	MC	8,800
CADMIUM	<1	<2	SELENIUM	6	N.R.
CALCIUM	MC	39,400	SILVER	<1	<30
CHROMIUM	5	<2	SODIUM	>3,000	175,000
COBALT	8	<2	STRONTIUM	200	160
COPPER	10	1	TIN	4	<10
GALLIUM	<1	<20	TITANIUM	100	<1
IRON	50	10	VANADIUM	<1	<5
LEAD	5	<30	YTTRIUM	3	<1
LITHIUM	10	17	ZINC	30	12

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 07-01 Pond No. 1 Sediment Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	30	10	MAGNESIUM	900	5,210
ANTIMONY	<1	<10	MANGANESE	100	276
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	90	80	MOLYBDENUM	40	42
BERYLLIUM	<1	<1	NICKEL	6	<5
BORON	<1	469	POTASSIUM	MC	6,200
CADMIUM	<1	<2	SELENIUM	2	N.R.
CALCIUM	MC	38,800	SILVER	<1	<30
CHROMIUM	20	<2	SODIUM	>2,000	99,500
COBALT	≤1	<2	STRONTIUM	100	173
COPPER	10	3	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	40	<1
IRON	500	15	VANADIUM	<1	<5
LEAD	4	<30	YTTRIUM	2	<1
LITHIUM	3	5	ZINC	20	84

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 08-01 Pond No. 2 Sediment Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	10	30	MAGNESIUM	1,000	1,780
ANTIMONY	<1	<10	MANGANESE	200	316
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	30	21	MOLYBDENUM	30	20
BERYLLIUM	<1	<1	NICKEL	5	<5
BORON	2	156	POTASSIUM	3,000	1,200
CADMIUM	<1	<2	SELENIUM	2	N.R.
CALCIUM	8,000	8,120	SILVER	<1	<30
CHROMIUM	<1	<2	SODIUM	>2,000	50,000
COBALT	<1	<2	STRONTIUM	40	37
COPPER	20	2	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	20	<1
IRON	40	28	VANADIUM	<1	<5
LEAD	<2	<30	YTTRIUM	<1	<1
LITHIUM	<1	1	ZINC	40	20

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 48-01 Duplicate - Pond No. 2 Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	30	30	MAGNESIUM	800	1,860
ANTIMONY	<1	<10	MANGANESE	200	331
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	50	22	MOLYBDENUM	20	19
BERYLLIUM	<1	<1	NICKEL	10	<5
BORON	<1	109	POTASSIUM	3,000	1,300
CADMIUM		<2	SELENIUM	<1	N.R.
CALCIUM	MC	8,600	SILVER	<1	<30
CHROMIUM	<1	<2	SODIUM	>4,000	50,900
COBALT	≤3	<2	STRONTIUM	30	39
COPPER	10	3	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	200	<1
IRON	40	18	VANADIUM	<1	<5
LEAD	<6	<30	YTTRIUM	<1	<1
LITHIUM	2	1	ZINC	30	<2

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 09-01 Pond No. 3 Sediment Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	50	50	MAGNESIUM	1,000	2,490
ANTIMONY	<1	<10	MANGANESE	200	716
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	30	15	MOLYBDENUM	100	4
BERYLLIUM	<1	<1	NICKEL	20	<5
BORON	<1	60	POTASSIUM	2,000	1,100
CADMIUM	<1	<2	SELENIUM	6	N.R.
CALCIUM	MC	7,120	SILVER	<1	<30
CHROMIUM	1	<2	SODIUM	>2,000	30,900
COBALT	<1	<2	STRONTIUM	200	39
COPPER	6	1	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	100	1
IRON	600	48	VANADIUM	7	<5
LEAD	8	<30	YTTRIUM	<1	<1
LITHIUM	6	<1	ZINC	30	2

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 04-02 Fine Waste Slurry Leachate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	1,000	190	MAGNESIUM	4,000	6,720
ANTIMONY	<1	10	MANGANESE	20	75
ARSENIC	≤4	N.R.	MERCURY	N.R.	N.R.
BARIUM	30	18	MOLYBDENUM	30	39
BERYLLIUM	<1	<1	NICKEL	20	8
BORON	20	685	POTASSIUM	>12,000	9,900
CADMIUM	<1	<2	SELENIUM	10	N.R.
CALCIUM	130,000	72,800	SILVER	<1	<30
CHROMIUM	2	11	SODIUM	<2,000	375,000
COBALT	1	3	STRONTIUM	200	335
COPPER	1	3	TIN	<1	<10
GALLIUM	1	<20	TITANIUM	1,000	4
IRON	60	182	VANADIUM	2	<5
LEAD	≤4	<30	YTTRIUM	<1	<1
LITHIUM	6	29	ZINC	10	<2

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 12-02 Feedwater Filtrate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	50	60	MAGNESIUM	4,000	2,530
ANTIMONY	<1	<10	MANGANESE	5	9
ARSENIC	<1	N.R.	MERCURY	N.R.	N.R.
BARIUM	10	20	MOLYBDENUM	10	31
BERYLLIUM	<1	<1	NICKEL	20	<5
BORON	40	365	POTASSIUM	4,000	2,900
CADMIUM	<1	<2	SELENIUM	5	N.R.
CALCIUM	MC	11,300	SILVER	<1	<30
CHROMIUM	2	<2	SODIUM	>2,000	138,000
COBALT	<1	<2	STRONTIUM	30	62
COPPER	10	<1	TIN	<1	58
GALLIUM	1	<20	TITANIUM	300	<1
IRON	200	175	VANADIUM	2	<5
LEAD	≤3	<30	YTTRIUM	1	<1
LITHIUM	3	5	ZINC	20	<2

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 15-02 Pond Water No. 1 Filtrate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	>900	280	MAGNESIUM	4,000	3,240
ANTIMONY	<1	<10	MANGANESE	10	7
ARSENIC	≤4	N.R.	MERCURY	N.R.	N.R.
BARIUM	50	65	MOLYBDENUM	20	73
BERYLLIUM	<1	<1	NICKEL	20	6
BORON	40	578	POTASSIUM	MC	5,400
CADMIUM	<1	<2	SELENIUM	10	N.R.
CALCIUM	MC	32,400	SILVER	<1	<30
CHROMIUM	2	4	SODIUM	>2,000	285,000
COBALT	≤1	<2	STRONTIUM	70	158
COPPER	6	2	TIN	<1	50
GALLIUM	1	<20	TITANIUM	1	3
IRON	200	125	VANADIUM	6	<5
LEAD	4	<30	YTTRIUM	<1	<1
LITHIUM	3	18	ZINC	30	8

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412
Sample No.: 18-02 Pond Water No. 2 Filtrate

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	>400	220	MAGNESIUM	2,000	1,600
ANTIMONY	<1	<10	MANGANESE	2	3
ARSENIC	≤1	N.R.	MERCURY	N.R.	N.R.
BARIUM	90	55	MOLYBDENUM	20	76
BERYLLIUM	<1	<1	NICKEL	6	<5
BORON	10	584	POTASSIUM	>4,000	4,400
CADMIUM	<1	<2	SELENIUM	2	N.R.
CALCIUM	MC	12,600	SILVER	<1	<30
CHROMIUM	2	<2	SODIUM	>900	236,000
COBALT	<1	<2	STRONTIUM	60	82
COPPER	5	<1	TIN	3	23
GALLIUM	<1	<20	TITANIUM	200	1
IRON	90	88	VANADIUM	1	<5
LEAD	≤1	<30	YTTRIUM	<1	<1
LITHIUM	2	14	ZINC	10	<2

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80
Report No:
Batch No.: 553.412   Pond Water No. 3 Filtrate
Sample No.: 21-02

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	>800	2,700	MAGNESIUM	4,000	3,140
ANTIMONY	<1	<10	MANGANESE	10	52
ARSENIC	2	N.R.	MERCURY	N.R.	N.R.
BARIUM	90	37	MOLYBDENUM	9	40
BERYLLIUM	<1	<1	NICKEL	30	<5
BORON	30	190	POTASSIUM	10,000	4,000
CADMIUM	<1	<2	SELENIUM	5	N.R.
CALCIUM	MC	13,700	SILVER	<1	<30
CHROMIUM	7	4	SODIUM	>2,000	147,000
COBALT	≤1	<2	STRONTIUM	30	73
COPPER	5	2	TIN	<1	34
GALLIUM	1	<20	TITANIUM	40	12
IRON	500	1,790	VANADIUM	6	<5
LEAD	<1	<30	YTTRIUM	<1	<1
LITHIUM	3	7	ZINC	5	5

N.R. - Not Reported
INT - Interference
*(N)- Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 24-02 Clean Coal Storage Pile Runoff

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	20	190	MAGNESIUM	3,000	57,900
ANTIMONY	<1	36	MANGANESE	400	1,900
ARSENIC	≤3	N.R.	MERCURY	N.R.	N.R.
BARIUM	80	41	MOLYBDENUM	≤4	<4
BERYLLIUM	<1	<1	NICKEL	500	144
BORON	70	1,012	POTASSIUM	>9,000	4,000
CADMIUM	<1	8	SELENIUM	4	N.R.
CALCIUM	MC	508,000	SILVER	<1	<30
CHROMIUM	400	20	SODIUM	>2,000	305,000
COBALT	20	68	STRONTIUM	3,000	2,362
COPPER	9	10	TIN	<1	<10
GALLIUM	<1	<20	TITANIUM	2,000	7
IRON	10	47	VANADIUM	2	<5
LEAD	3	<30	YTTRIUM	20	9
LITHIUM	10	13	ZINC	500	351

N.R. - Not Reported

INT - Interference

*(N)- Mean of (N) Analysis

MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 27-02 Coarse Refuse Pile Runoff

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	80	940	MAGNESIUM	MC	14,800
ANTIMONY	<1	<10	MANGANESE	900	2,010
ARSENIC	≤3	N.R.	MERCURY	N.R.	N.R.
BARIUM	30	42	MOLYBDENUM	20	36
BERYLLIUM	<1	<1	NICKEL	40	24
BORON	100	424	POTASSIUM	>8,000	6,400
CADMIUM	<1	2	SELENIUM	≤8	N.R.
CALCIUM	MC	93,700	SILVER	<1	<30
CHROMIUM	<1	14	SODIUM	>2,000	454,000
COBALT	1	8	STRONTIUM	400	505
COPPER	2	8	TIN	<1	196
GALLIUM	1	<20	TITANIUM	200	16
IRON	200	601	VANADIUM	2	<5
LEAD	≤2	<30	YTTRIUM	2	1
LITHIUM	10	27	ZINC	40	<2

N.R. - Not Reported
INT - Interference
*(N) - Mean of (N) Analysis
MC - Major Component

ICP ANALYTICAL REPORT

Date: 2/11/80

Report No:

Batch No.: 553.412

Sample No.: 30-02 ROM Coal Storage Pile Runoff

CONCENTRATION IN: ppb

ELEMENT:	SSMS:	CONC:	ELEMENT:	SSMS:	CONC:
ALUMINUM	10	80	MAGNESIUM	9,000	23,500
ANTIMONY	<1	<10	MANGANESE	100	146
ARSENIC	≤8	N.R.	MERCURY	N.R.	N.R.
BARIUM	50	58	MOLYBDENUM	10	<4
BERYLLIUM	<1	<1	NICKEL	30	12
BORON	20	167	POTASSIUM	MC	4,300
CADMIUM	<1	<2	SELENIUM	<1	N.R.
CALCIUM	MC	130,000	SILVER	<1	<30
CHROMIUM	≤5	7	SODIUM	>5,000	125,000
COBALT	≤3	<2	STRONTIUM	3	482
COPPER	3	2	TIN	<1	<10
GALLIUM	2	<20	TITANIUM	900	3
IRON	100	51	VANADIUM	<1	<5
LEAD	≤7	<30	YTTRIUM	≤6	<1
LITHIUM	1	3	ZINC	30	19

N.R. - Not Reported

INT - Interference

*(N)- Mean of (N) Analysis

MC - Major Component

APPENDIX C

WATER QUALITY DATA

VERSAR ANALYTICAL REPORT NO. 553.412-1 (Control No. 553.412-63)

TO ON 11/20/79

TO THE ATTENTION OF Jean Buroff/Jerry Strauss

CONCERNING Wet Chemical Analysis of Samples Received 10/12/79

SUMMARY OF RESULTS:

Enclosed are the data for the analyses of 16 water samples from Coal Preparation Plant No. 1. The data are reported in the forms provided. The samples were analyzed according to the following methods.

Biochemical Oxygen Demand (BOD_5): Method No. 405.1

Chemical Oxygen Demand (COD): Method No. 410.1

Fluoride (F): Method No. 340.2

Reference:

Methods for Chemical Analysis of Water and Wastes, March 1979, EMSL, US EPA, Ohio

Nayana Talsania
PROJECT SUPERVISOR

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source Fine Waste Slurry Filtrate

Test Number Sample ID Number 04-06, 07 (9404)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	22.6		22.6	2.0		mg/l
BOD_5	3.0		3.0	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.85		0.85	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source Feedwater Filtrate

Test Number Sample ID Number 12-06,07 (9405)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	6.9		6.9	2.0		mg/l
BOD_5	1.1		1.1	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.92		0.92	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source Pond Water No. 1 Filtrate

Test Number Sample ID Number 15-06, 07 (9406)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	18.7		18.7	2.0		mg/l
BOD_5	1.9		1.9	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	1.3		1.3	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source Pond Water No. 2 Filtrate

Test Number Sample ID Number 18-06, 07 (9407)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	10.8		10.8	2.0		mg/l
BOD_5	2.3		2.3	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	1.3		1.3	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor ______

Sample Size ______ Sample Acquisition Date 10-12-79

Type of Source Pond Water No. 3 Filtrate

Test Number ______ Sample ID Number 21-06, 07 (9408)

Sample Description ______

Analyst Responsible Mike Buchanan Date Analyzed ______ Time ______

Calculations and Report Reviewed By ______ Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	12.8		12.8	2.0		mg/l
BOD_5	2.3		2.3	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.90		0.90	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor ______

Sample Size ______ Sample Acquisition Date 10-12-79

Type of Source Clean Coal Storage Pile Runoff

Test Number ______ Sample ID Number 24-06, 07 (9409)

Sample Description ______

Analyst Responsible Mike Buchanan Date Analyzed ______ Time ______

Calculations and Report Reviewed By ______ Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	16.7		16.7	2.0		mg/l
BOD_5	1.6		1.6	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.45		0.45	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source Coarse Refuse Pile Runoff

Test Number Sample ID Number 27-06, 07 (9410)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	22.6		22.6	2.0		mg/l
BOD_5	5.0		5.0	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.60		0.60	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

WATER QUALITY ANALYSIS

Contractor

Sample Size Sample Acquisition Date 10-12-79

Type of Source ROM Storage Pile Runoff

Test Number Sample ID Number 30-06, 07 (9411)

Sample Description

Analyst Responsible Mike Buchanan Date Analyzed Time

Calculations and Report Reviewed By Report Date 11-20-79

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calib. Stds. or Conc. Added	Assigned Conc.
COD	14.8		14.8	2.0		mg/l
BOD_5	4.7		4.7	1.0		mg/l
pH						
Conductivity						µmhos/cm
TSS						mg/l
% Solids						
Hardness						mg/l
Alkalinity						mg/l
Acidity						mg/l
NH_3-N						mg/l
NO_3-N						mg/l
NO_2-N						mg/l
Cyanide						mg/l
Ortho Phosphate						mg/l
Total Phosphorous						mg/l
Sulfide						mg/l
Sulfate						mg/l
F	0.185		0.185	0.1		mg/l
Cl						mg/l
Br						mg/l

Results: Concentration measured in original sample on I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<σ blank or baseline).

VERSAR ANALYTICAL REPORT NO. 553.412-E-94

TO ____________________ ON 1/4/80

TO THE ATTENTION OF Jean Buroff/Jerry Strauss

CONCERNING Water Quality Analysis of Leachate Samples from Coal Preparation Plant No. 1 - Batches 2 & 4

SUMMARY OF RESULTS:

Enclosed are the data for the water quality analysis of leachate samples from the Breckenridge Coal Cleaning plant. The leachate samples were prepared by S. Powers according to the proposed methods for leaching of waste materials by ASTM. One part of wet material was mixed with four parts of deionized water. The procedures used for analysis are referenced below.

COD: Method No. 508, Ref. 1
BOD: Method No. 507, Ref. 1
pH: Method No. 150.1, Ref. 2
Conductivity: Method No. 120.1, Ref. 2
TSS: Method No. 208D, Ref. 1
Hardness: Method No. 309B, Ref. 1
Alkalinity: Method No. 310.1, Ref. 2
Acidity: Method No. 305.1, Ref. 2
NH_3-N: Method No. 350.1, Ref. 2
NO_3-N: Method No. 353.2, Ref. 2
NO_2-N: Method No. 353.2, Ref. 2
Ortho-Phosphate: Method No. 365.2, Ref. 2
Total Phosphorus: Method No. 365.2, Ref. 2
Sulfide: Method No. 376.1, Ref. 2
Sulfate: Method No. 375.2, Ref. 2
Fluoride: Method No. 414B, Ref. 1
Chloride: Method No. 325.3, Ref. 2
% Solids: Method No. 208G, Ref. 1

Ref. 1 - 14th Edition, Standard Methods for the Examination of Water and Wastewater, 1975.
Ref. 2 - EPA Methods for Chemical Analysis of Water and Wastes, March 1979.

Nayana Talsania
PROJECT SUPERVISOR

LABORATORY WATER QUALITY ANALYSIS

Control No. ________

Lab No. 9814 Sample ID No. 07-02

Sample Description Leachate Pond No. 1 Sediment

Sample Receipt Date 10/24/79 Date Analysis Completed 12/21/79

Lab Supervisor N. Talsania Date Reported 12/31/79

Report Reviewed By ________

Remarks ________

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	16.1	1.0	mg/l
BOD_5		<1.0	1.4	1.0	mg/l
pH			8.2		
Conductivity			600.		umhos/cm
TSS					mg/l
% Solids			68.		
Hardness		<1.0	125.	1.0	mg/l
Alkalinity		<1.0	142.	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	0.19	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	<0.01	0.01	mg/l
Total Phosphorous		<0.01	0.025	0.01	mg/l
Sulfide		<1.0	1.9	1.0	mg/l
Sulfate		<1.0	212.	1.0	mg/l
F		<0.05	0.86	0.05	mg/l
Cl		<1.0	5.1	1.0	mg/l
Br					mg/l

LABORATORY WATER QUALITY ANALYSIS

Control No.

Lab No. 9815 Sample ID No. 08-02

Sample Description Leachate Pond No. 2 Sediment

Sample Receipt Date 10/24/79 Date Analysis Completed 12/21/79

Lab Supervisor N. Talsania Date Reported 12/31/79

Report Reviewed By

Remarks

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	18.0	2.0	mg/l
BOD_5		<1.0	3.3	1.0	mg/l
pH			8.3		
Conductivity			198.		umhos/cm
TSS					mg/l
% Solids			64.		
Hardness		<1.0	31.7	1.0	mg/l
Alkalinity		<1.0	86.9	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	0.11	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	0.08	0.01	mg/l
Total Phosphorous		<0.01	0.03	0.01	mg/l
Sulfide		<1.0	1.9	1.0	mg/l
Sulfate		<1.0	66.	1.0	mg/l
F		<0.05	0.76	0.05	mg/l
Cl		<1.0	3.1	1.0	mg/l
Br					mg/l

LABORATORY WATER QUALITY ANALYSIS

Control No.

Lab No. 9816 Sample ID No. 09-02

Sample Description Leachate Pond No. 3 Sediment

Sample Receipt Date 10/24/79 Date Analysis Completed 12/21/79

Lab Supervisor N. Talsania Date Reported 12/31/79

Report Reviewed By

Remarks

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	12.3	2.0	mg/l
BOD_5		<1.0	1.6	1.0	mg/l
pH			8.0		
Conductivity			145.		umhos/cm
TSS					mg/l
% Solids			71.		
Hardness		<1.0	10.1	1.0	mg/l
Alkalinity		<1.0	51.6	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	0.14	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	0.085	0.01	mg/l
Total Phosphorous		<0.01	0.035	0.01	mg/l
Sulfide		<1.0	1.9	1.0	mg/l
Sulfate		<1.0	52.	1.0	mg/l
F		<0.05	0.38	0.05	mg/l
Cl		<1.0	<1.0	1.0	mg/l
Br					mg/l

LABORATORY WATER QUALITY ANALYSIS

Control No.

Lab No. 215 Sample ID No. 01-02 Clean Coal

Sample Description Leachate

Sample Receipt Date 11/17/79 Date Analysis Completed 12/21/79

Lab Supervisor N. Talsania Date Reported 12/31/79

Report Reviewed By

Remarks

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	25.5	2.0	mg/l
BOD_5		<1.0	19.8	1.0	mg/l
pH			8.0		
Conductivity			700.		μmhos/cm
TSS					mg/l
% Solids			95.		
Hardness		<1.0	324.	1.0	mg/l
Alkalinity		<1.0	90.7	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	0.44	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	<0.01	0.01	mg/l
Total Phosphorous		<0.01	0.02	0.01	mg/l
Sulfide		<1.0	2.1	1.0	mg/l
Sulfate		<1.0	300.	1.0	mg/l
F		<0.05	0.12	0.05	mg/l
Cl		<1.0	46.3	1.0	mg/l
Br					mg/l

LABORATORY WATER QUALITY ANALYSIS

Control No.
Lab No. 216 Sample ID No. 06-02 Coarse Refuse
Sample Description Leachate
Sample Receipt Date 11/17/79 Date Analysis Completed 12/21/79
Lab Supervisor N. Talsania Date Reported 12/31/79
Report Reviewed By
Remarks

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	92.2	2.0	mg/l
BOD_5		<1.0	87.4	1.0	mg/l
pH			8.4		
Conductivity			1480.		umhos/cm
TSS					mg/l
% Solids			97.		
Hardness		<1.0	46.2	1.0	mg/l
Alkalinity		<1.0	317.	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	1.36	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	<0.01	0.01	mg/l
Total Phosphorous		<0.01	0.02	0.01	mg/l
Sulfide		<1.0	7.7	1.0	mg/l
Sulfate		<1.0	520.	1.0	mg/l
F		<0.05	0.70	0.05	mg/l
Cl		<1.0	96.7	1.0	mg/l
Br					mg/l

LABORATORY WATER QUALITY ANALYSIS

Control No.

Lab No. 217 Sample ID No. 05-02 Pcm Coal

Sample Description Leachate

Sample Receipt Date 11/17/79 Date Analysis Completed 12/21/79

Lab Supervisor N. Talsania Date Reported 12/31/79

Report Reviewed By

Remarks

Parameter	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Detection Limit	Assigned Conc.
COD		<2.0	45.1	2.0	mg/l
BOD_5		<1.0	31.2	1.0	mg/l
pH			8.0		
Conductivity			900.		umhos/cm
TSS					mg/l
% Solids			95.		
Hardness		<1.0	114.	1.0	mg/l
Alkalinity		<1.0	110.	1.0	mg/l
Acidity		<1.0	<1.0	1.0	mg/l
NH_3-N		<0.05	0.83	0.05	mg/l
NO_3-N		<0.05	<0.05	0.05	mg/l
NO_2-N		<0.05	<0.05	0.05	mg/l
Cyanide					mg/l
Ortho Phosphate		<0.01	<0.01	0.01	mg/l
Total Phosphorous		<0.01	0.02	0.01	mg/l
Sulfide		<1.0	2.6	1.0	mg/l
Sulfate		<1.0	330.	1.0	mg/l
F		<0.05	0.25	0.05	mg/l
Cl		<1.0	73.0	1.0	mg/l
Br					mg/l

SUMMARY OF RESULTS: MERCURY ANALYSES

WATER SAMPLES ONLY

Enclosed are the data for the analyses of eight water samples from the coal cleaning plant No. 1. The samples were analyzed according to the following method:

Mercury - Method 245.1 (Manual Cold Vapor Technique)

Reference: Methods for Chemical Analysis of Water and Wastes,
March 1979, EMSL, US EPA, Ohio

SOLID SAMPLES ONLY

Enclosed are the Hg data for the analyses of 13 solid samples from coal cleaning plant No. 1. The samples were prepared utilizing the aqua regia digestion procedure described in Appendix D or IERL-RTP Procedures Manual: Level 1 Environmental Assessment (second edition). After preparation, the samples were analyzed according to the following method:

Mercury: Method 245.1 (Manual Cold Vapor Technique)[1]

[1] Methods for Chemical Analysis of Water and Wastes, March 1979, EMSL, US EPA, Cinn., Ohio.

SUMMARY OF RESULTS: MERCURY ANALYSES

FILTER PADS/FUGITIVE DUSTS ONLY

Enclosed are the data for the analyses of six filter pad samples from the coal cleaning plant No. 1. The samples were prepared utilizing the aqua regia digestion procedure described in Appendix D of IERL-RTP Procedures Manual: Level 1 Environmental Assessment (second edition). After preparation, the samples were analyzed according to the following method:

Mercury: Method 245.1 (Manual Cold Vapor Technique)[1]

[1] Methods for Chemical Analysis of Water and Wastes, March 1979, EMSL, US EPA, Cinn., Ohio.

LEACHATE SAMPLES ONLY

Enclosed are the data for the analyses of six water samples from the coal cleaning plant No. 1. The samples were analyzed according to the following method:

Mercury - Method 245.1 (Manual Cold Vapor Technique)

Reference: Methods for Chemical Analysis of Water and Wastes, March 1979, EMSL, US EPA, Ohio

LABORATORY AAS ANALYSIS SHEET

Control No. ______

Lab No. 215 Sample ID No. 01-02

Sample Description Clean Coal

Sample Receipt Date 11/7/79 Date Analysis Completed 2/13/80

Lab Supervisor MaxField Date Reported 2/14/80

Report Reviewed by ~~MaxField~~

Remarks ______

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 4.6462 grams to 100 ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000000
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.000000
Assigned Concentration*	N.D. (< 0.04 μg/gram)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9813 Sample ID No. 03-02

Sample Description Fine Slurry Solids

Sample Receipt Date

Date Analysis Completed 2/13/80

Lab Supervisor Maxfield

Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 11.5658 grams to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000859
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0030
Assigned Concentration*	N.D. (< 0.04 ug/gram)

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 216 Sample ID No. 0602

Sample Description Course Refuse

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 4.5797g to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.001861
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.007012
Assigned Concentration*	0.15 ug/gram

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 217 Sample ID No. 05-02

Sample Description ROM Coal

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Muxfeld Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 5.3906 grams to 100 ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.004927
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0193
Assigned Concentration*	0.36 µg/gram

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9814 Sample ID No. 07-02

Sample Description Pond No. 1 Sediment

Sample Receipt Date

Date Analysis Completed 2/13/80

Lab Supervisor

Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 6.8070 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000233
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0005
Assigned Concentration*	← N.D.

< 0.04 ug/gram

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9815 Sample ID No. 08-02

Sample Description Pond No.2 Sediment

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 4.7810 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000 000
Blank Value (ppm)	0.000 108
Corrected Sample Aliquot Value (ppm)	0.00000
Assigned Concentration*	N.D. (< 0.04 μg/gram)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9816 Sample ID No. 09.02

Sample Description Pond No.3 Sediment

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 3.8631 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000046
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.00000
Assigned Concentration*	N.D. (< 0.04 ug/gram)

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9805 Sample ID No. 04-02

Sample Description Fine Waste Slurry Filtrate

Sample Receipt Date Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9806 Sample ID No. 12-02

Sample Description Feedwater Filtrate

Sample Receipt Date ______ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks ______

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	0.0002
Assigned Concentration*	0.0002 ± 0.0002

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9807 Sample ID No. 15-02

Sample Description Pond Water No. 1 Filtrate

Sample Receipt Date ______ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9808 Sample ID No. 18-02

Sample Description Pond Water No. 2 Filtrate

Sample Receipt Date ______ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks ______

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9809 Sample ID No. 21-02

Sample Description Pond Water No. 3 Filtrate

Sample Receipt Date ____ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks ____

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9820 Sample ID No. 23 - 02

Sample Description Clean Coal Storage Pile Vapors

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 5.4975 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000171
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0003
Assigned Concentration*	N.D. (< 0.04 µg/gram)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. ________

Lab No. 9821 Sample ID No. 26-62

Sample Description Coarse Refuse Pile Vapors

Sample Receipt Date ________ Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by ________

Remarks ________

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 4.7585 to 100 ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000671
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0023
Assigned Concentration*	0.05 μg/gram

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9822 Sample ID No. 29-02

Sample Description ROM Storage Pile Vapors

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 6.3470 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000000
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.00000
Assigned Concentration*	N.D. (< 0.04 ug/gm)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9823 Sample ID No. 32-02

Sample Description Upwind Vapors

Sample Receipt Date Date Analysis Completed 2/13/80

Lab Supervisor Maxfield Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 6.0286 to 100 ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000233
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0005
Assigned Concentration*	N.D. (< 0.04 μg/gm)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. ____________

Lab No. 9824 Sample ID No. 35-02

Sample Description Downwind Vapors

Sample Receipt Date ____________ Date Analysis Completed 2/13/80

Lab Supervisor Max Fidl Date Reported 2/14/80

Report Reviewed by ____________

Remarks ____________

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 4.8904 t. 100 ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000233
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0005
Assigned Concentration*	N.D. (< 0.04 µg/gram)

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9825

Sample ID No. 43-02

Sample Description XAD Resin Blank

Sample Receipt Date

Date Analysis Completed 2/13/80

Lab Supervisor Maxfield

Date Reported 2/14/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ 6.2651 to 100ml
Dilution Factor	1:4
Uncorrected Sample Aliquot Value (ppm)	0.000421
Blank Value (ppm)	0.000108
Corrected Sample Aliquot Value (ppm)	0.0013
Assigned Concentration*	N.D. (< 0.04 μg/gram)

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 162 Sample ID No. 22 - 02

Sample Description Clean Coal Storage Pile Particulates

Sample Receipt Date Date Analysis Completed 12-7-79

Lab Supervisor Date Reported

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Pad
Dilution Factor	100 ml × 2
Uncorrected Sample Aliquot Value (ppm)	0.0006
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	0.0006
Assigned Concentration*	0.12 *

* ug/pad

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

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LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 163

Sample ID No. 25-02

Sample Description Coarse Refuse Pile Particulates

Sample Receipt Date

Date Analysis Completed 12-7-79

Lab Supervisor

Date Reported

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Pad
Dilution Factor	100 ml x 2
Uncorrected Sample Aliquot Value (ppm)	0.0004
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	0.0004
Assigned Concentration*	0.08 *

* ug/pad

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 114 Sample ID No. 28-02

Sample Description ROM Storage Pile Particulates

Sample Receipt Date Date Analysis Completed 12-7-79

Lab Supervisor Maxfield Date Reported

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Pad
Dilution Factor	100 ml x 2
Uncorrected Sample Aliquot Value (ppm)	0.0010
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	0.0010
Assigned Concentration*	0.20 *

ug/pad

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. ______

Lab No. 165 Sample ID No. 31-02

Sample Description Upwind Particulates

Sample Receipt Date ______ Date Analysis Completed 12-7-79

Lab Supervisor Maxfield Date Reported ______

Report Reviewed by ______

Remarks ______

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Pool
Dilution Factor	100 ml x 2
Uncorrected Sample Aliquot Value (ppm)	0.0008
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	0.0008
Assigned Concentration*	0.16 ug/pool

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 166 Sample ID No. 34-C2

Sample Description Downwind Particulates

Sample Receipt Date Date Analysis Completed 12-7-79

Lab Supervisor Maxfield Date Reported

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Filter Pad
Dilution Factor	100 ml x 2
Uncorrected Sample Aliquot Value (ppm)	0.0007
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	0.0007
Assigned Concentration*	0.14 ug/pad

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 167 Sample ID No. 44-02

Sample Description Blank Filter

Sample Receipt Date Date Analysis Completed 12-7-79

Lab Supervisor Maxfield Date Reported

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	~~100~~ Filter Pad
Dilution Factor	100 ml x2
Uncorrected Sample Aliquot Value (ppm)	0.0006
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	0.0006
Assigned Concentration*	0.12 µg/pad

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9810 Sample ID No. 24-02

Sample Description Clean Coal Storage Pile Runoff

Sample Receipt Date ________ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks ________

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	0.0002
Assigned Concentration*	0.0002 ± 0.0002

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9811 Sample ID No. 27-02

Sample Description Coarse Refuse Pile Runoff

Sample Receipt Date ____ Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. Versar Inc.

Lab No. 9812 Sample ID No. 30-02

Sample Description ROM Storage Pile Runoff

Sample Receipt Date Date Analysis Completed 10/29/79

Lab Supervisor R. Maxfield Date Reported 11/16/79

Report Reviewed by S. Powers

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	<0.0002
Blank Value (ppm)	<0.0002
Corrected Sample Aliquot Value (ppm)	<0.0002
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

37

Control No.

Lab No. 215 Sample ID No. 37-02

Sample Description Clean Coal Leachate.

Sample Receipt Date Date Analysis Completed 11/29/79

Lab Supervisor Maxfield Date Reported 2/4/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	< 0.0002
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	< 0.0002
Assigned Concentration*	N.D.

ug/l

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. ______

Lab No. 217 Sample ID No. 38-02

Sample Description ROM Coal Leachate

Sample Receipt Date ______ Date Analysis Completed 11/29/79

Lab Supervisor ______ Date Reported 2/4/80

Report Reviewed by Maxfield

Remarks ______

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	< 0.0002
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	< 0.0002 ug/ml
Assigned Concentration*	N.D.

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

39

Control No. ____________________

Lab No. 216 Sample ID No. 39-02

Sample Description Coarse Refuse Leachate

Sample Receipt Date ____________ Date Analysis Completed 11/29/79

Lab Supervisor Max F. Dd Date Reported 2/4/80

Report Reviewed by ____________________

Remarks ____________________

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (μg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	< 0.0002 *
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	< 0.0002 * ug/ml
Assigned Concentration*	N.D.

* Represent mean of 2 analyses

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No. 40

Lab No. 9814 07-01 Sample ID No. 40-02

Sample Description Pond No. 1 Sediment Leachate

Sample Receipt Date

Date Analysis Completed 11/29/79

Lab Supervisor M. Field

Date Reported 2/4/90

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	< 0.0002
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	< 0.0002 ug/ml
Assigned Concentration*	ND

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9815 Sample ID No. 41-02

Sample Description Pond No.2 Sediment Leachate

Sample Receipt Date Date Analysis Completed 11/29/79

Lab Supervisor Maxfield Date Reported 2/4/80

Report Reviewed by

Remarks

	Hg	
Instrument Used	P-E 306	
Wavelength Setting (nm)	253.6	
Lamp Current (ma)	6	
Detection Limit (μg)	0.02	
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100(ml)	
High/Low Calibration Standards (ppm)	0.0100 - 0.0002	
Sample Aliquot Volume (ml)	100	
Dilution Factor	None	
Uncorrected Sample Aliquot Value (ppm)	< 0.0002	*
Blank Value (ppm)	< 0.0002	
Corrected Sample Aliquot Value (ppm)	< 0.0002	* ug/ml
Assigned Concentration*	N.D.	

* Represents Mean of 2 Analyses

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).

LABORATORY AAS ANALYSIS SHEET

Control No.

Lab No. 9816 Sample ID No. 42-02

Sample Description Pond No. 3 Sediment Leachate

Sample Receipt Date Date Analysis Completed 11/29/79

Lab Supervisor Maxfield Date Reported 2/4/80

Report Reviewed by

Remarks

	Hg
Instrument Used	P-E 306
Wavelength Setting (nm)	253.6
Lamp Current (ma)	6
Detection Limit (µg)	0.02
Sensitivity (abs. units/ppm/sample volume)	222/0.010/100 (ml)
High/Low Calibration Standards (ppm)	0.0100 - 0.0002
Sample Aliquot Volume (ml)	100
Dilution Factor	None
Uncorrected Sample Aliquot Value (ppm)	< 0.0002
Blank Value (ppm)	< 0.0002
Corrected Sample Aliquot Value (ppm)	< 0.0002
Assigned Concentration*	N. D.

ug/l

*Results: PPM value (in original sample) or I - interference: NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank or baseline).